Vol. 32 October, 1938 No. 2

QUARTERLY

OF THE

National Fire Protection Association

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60 BATTERYMARCH STREET, BOSTON, MASS.

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Associate Membership is open to any Society, Firm, Corporation or Individual interested in the protection of life and property against loss by fire. Persons in every walk of life are members.

National Fire Protection Association

INTERNATIONAL

Organized 1896

EXECUTIVE OFFICE: 60 BATTERYMARCH STREET, BOSTON, MASSACHUSETTS

All the valuable engineering and popular literature issued by the Association is sent, as issued, to every member.

We furnish free to members the Regulations issued by the National Board of Fire Underwriters, and the lists of devices and materials inspected by Underwriters' Laboratories, Inc.

The Association is the clearing house for all the authoritative information on Fire Protection and Prevention and members are privileged to submit to it their individual problems for solution.

PUBLICATIONS

Quarterly Magazine of the Association. A chronicle of the Association's activities, with valuable contributions of articles on fire prevention and protection and special hazards, and compilations of fire statistics on various classes of property.

News Letter. A special monthly bulletin of timely information on fire prevention and kindred subjects.

Proceedings of Annual Meeting. Containing stenographic report of transactions of the Association and the discussions incident to the adoption of its standards.

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Index to all subjects covered in the Printed Records.

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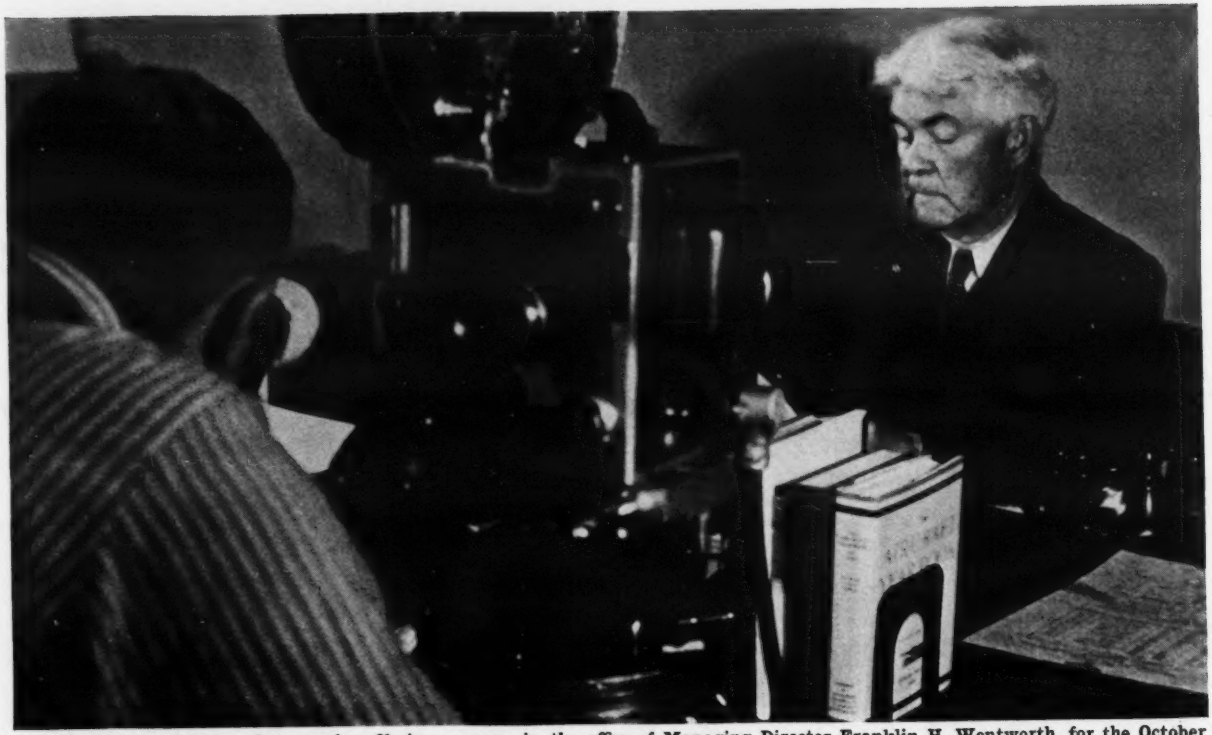


The March of Time photographer filming a scene in the office of Managing Director Franklin H. Wentworth, for the October release, "U. S. Fire Fighters."

The Quarterly

Vol. 32 October, 1938 No. 2

Book Learning for Firemen. The Crosby-Fiske-Forster Handbook of Fire Protection and many other N.F.P.A. publications are being increasingly distributed to firemen and junior officers of fire departments who are preparing themselves for civil service examinations for promotion. This is a most commendable development. Everyone is agreed as to the desirability of an increasing amount of technical knowledge in fire departments, and the effect of increasing educational requirements for the fire service cannot help but be beneficial. The time has long since passed when an ordinary grade school education, and nothing more, furnished all the educational background needed for advancement in the fire service.

The development of technical requirements for advancement in fire departments has apparently in some instances been too rapid to permit of the development of an adequate technique in the preparation and handling of civil service examinations. Book learning, valuable though it is, is only one of a number of factors which determine competence of men for fire department promotion. Judgment, practical experience, and qualities of leadership, all of paramount importance, cannot be covered in a written examination. Examinations can, however, be so handled as to bring out the candidate's ability to apply the knowledge which he has obtained rather than merely being a test of memory of what appears in books. It is a frequently heard complaint on the part of men studying for promotion that many of the questions asked on civil service examinations have little or no practical application in the fire service and that the grading of these papers may be on a more or less arbitrary basis with credit given for only one particular answer, whereas any one of several different solutions might be equally valid.

Firemen who are studying for promotional examinations frequently learn and have at their fingertips all sorts of formulae and constants for hydraulic computations, details with which the experienced hydraulic engineer does not burden his memory. These men may make detailed hydraulic computations in answering examination questions, whereas in practical application very slight variations in the size of hose or nozzles or in the accuracy of pressure gages are such that no great degree of refinement in computations is justified, and for actual work in fire fighting a rough calculation, accurate within 5 or 10

pounds per square inch or gallons per minute, is generally adequate. What seems to be needed is a better understanding upon the part of those responsible for the preparation and grading of civil service examinations of the relative importance and degree of accuracy called for in the numerous technical matters which come into play in the fire service. The type of examination which depends solely upon rote memory of books should be discarded and the questions framed in such a way as to test the intelligence and judgment of the applicant in addition to his memory. Certain engineering school examinations have long been conducted on such a basis. The student may bring into the examination room any books or notes that he desires and these he may consult freely during the examination period. In such examinations the questions are all new problems the answers to which are not found in any books. To answer them the student must know what facts and formulae are applicable, where to find them in his reference material, and must draw upon his own ingenuity and intelligence in answering the question. It is perhaps out of the question at present to have this type of examination for the fire service, but it would certainly be highly beneficial if the character of the questions and the grading of the answers could be handled in such a way as to show the candidate's ability to utilize technical information for application to practical problems rather than being merely a test of memory.

* * * * *

Hurricane and Flood. The hurricane and floods that devastated large areas on Long Island and in New England in September, like other catastrophes that have been visited upon other sections of the country from time to time, placed an overwhelming burden upon the fire protection forces of the regions affected. Fire, to the public mind, is a minor and incidental feature of such disasters, but it is only through herculean efforts of the public fire departments, and the fire protection fraternity in general, that fire does not multiply many fold the destruction wrought by the elements. With normal fire protection facilities seriously impaired, the fire protection forces must cope with extraordinary hazards, as well as meeting all sorts of emergency calls outside the line of usual fire duty.

With the unique combination of flood, hurricane and tidal wave it is indeed fortunate that fire did not take a greater toll. The New London, Connecticut, conflagration described in detail in this issue of the QUARTERLY, was stopped by the New London fire department with its limited personnel and equipment, the outside aid that might otherwise have been quickly assembled from other communities being unavailable because of blocked roads. The fire in Peterboro, New Hampshire (see photograph on page 98), though involving a much smaller monetary loss, was equally serious in proportion to the size of the community. Despite crippling of fire alarm service, tremendous damage to

electric power lines and communication service, thousands of chimneys fallen or cracked, roofs off buildings, gasoline and oil tanks damaged by flood or wind, and other damage too extensive to enumerate, the only major fires reported were those in New London and Peterboro. A subsequent fire in a New Bedford textile mill, with a loss variously estimated at over a million dollars, appears to have been an indirect aftermath, though no definite information is yet available on this fire as this QUARTERLY goes to press.

* * * * *

Lethal Fire Gases. Suffocation, rather than burns, is responsible for the great majority of the annual toll of deaths by fire. In the major fire catastrophes it is seldom that any large number of deaths are due to burns. Smoke and heated gases commonly prove fatal, even before the flames reach the victims, and there are many cases of death by fire where there is no evidence of any actual contact with flame or even any great degree of heat.

While the fire protection fraternity fully realizes the hazard of smoke and fire gases, there has been apparently very little thought given to the exact character of these gases and the circumstances of their lethal action. In many cases, to be sure, the heat, lack of oxygen, or the quantity of carbon monoxide given off by a fire in a confined space may readily account for fatalities. There are many other deaths, however, where it seems difficult to account for the fatality. The Plaza Hotel fire in Jersey City, for example (see QUARTERLY, April, 1938, page 314), involved deaths of persons on upper floors a long distance away from the fire, where it is difficult to believe that there was either sufficient heat or concentration of the ordinary gases of combustion to account for the deaths.

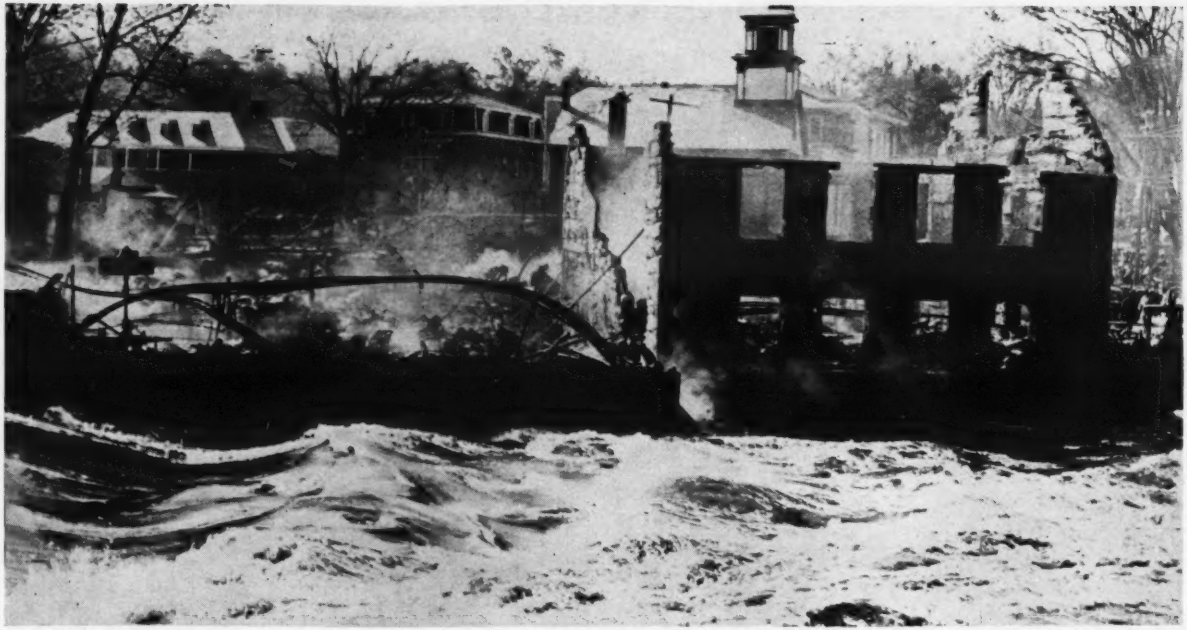
Carbon dioxide, which is produced in quantity in the burning of most combustible materials, is dangerous to life in sufficiently heavy concentrations, but it is an established fact that men can live for some time in an atmosphere containing so much carbon dioxide that any fire will be extinguished. Carbon monoxide, produced to some extent in the burning of most combustible substances, does not ordinarily occur in dangerous quantities except where fires burn in confined spaces with inadequate air supply. In the ordinary free-burning fire the slight quantity of carbon monoxide produced is not theoretically sufficient to cause fatalities. Various other gases, such as that of prussic acid, may also be produced in very small quantities during the burning of ordinary combustible materials. It has never been shown, however, that quantities of any one of such poisonous gases are sufficient to have a perceptible effect upon human life. What then can be the explanation of the frequently reported deaths by inhalation of fire gases? It may conceivably be possible that a combination of gases, each individually in too small a quantity to be dangerous, may

through combined action have fatal results. We do know that the presence of carbon dioxide stimulates breathing; this property is utilized in certain apparatus for artificial resuscitation. It might be that the presence of carbon dioxide in quantity too small itself to be dangerous could stimulate respiration to the extent that other gases, likewise in too small a concentration themselves to be dangerous, could be breathed at a sufficiently accelerated rate to affect life. There is also the possibility that under some special types of fire conditions there may be other gases which are not usually associated with the combustion of ordinary materials. There is also the possibility that some special types of materials used in modern building construction, furnishings, or equipment, may have unsuspected properties giving off dangerous gases under fire conditions.

All this speculation suggests the possibility of a fruitful field for research. Gas-sampling apparatus is seldom if ever available to take samples of the atmosphere in buildings where fires have caused fatalities, and while all sorts of researches have been conducted upon the toxic properties of individual gases, there is in the literature little if any record of research on the possible toxic effects of combinations of gases which may occur under fire conditions. The first step in preventing deaths from suffocation under fire conditions should be a more complete knowledge of the reasons for these fatalities, for it is only on the basis of adequate knowledge that the most effective preventive measures may be devised.

Boston's Portable Drill Tower.

What is believed to be the first large city portable drill tower designed for holding public exhibition drills in various parts of the city is shown above. The picture shows Boston firemen performing for the first time on the tower at a public exhibition held on historic Boston Common late in September and witnessed by approximately 10,000 people. The portable drill tower was the idea of Boston's Fire Commissioner, William Arthur Reilly, and Fire Chief Samuel J. Pope as a novel and effective method of interesting the public in the work of the Boston Fire Department. The portable drill tower, erected at various playgrounds and other public places throughout Boston during Fire Prevention Week, makes it possible for large numbers to witness fire department drill work. The tower is easily erected and dismantled and can be readily transported from place to place. It should not only prove effective in popularizing the work of the fire department, but inevitably increase the morale and enthusiasm of the men of the department in their chosen profession.



Heavy rains which preceded the hurricane of September 21, 1938, caused most New England rivers to overflow their banks. At Peterboro, New Hampshire, flood waters from the Contoocook River caused ignition of a carload of unslaked lime stored in a grain mill near the river. The fire started at 4:30 p.m., just as the windstorm reached the town. Flood waters made it impossible for fire apparatus housed on the opposite side of the river to reach the blaze. By the time outside help arrived the wind had driven the fire through the mill, two garages, a newspaper plant and a mercantile block, causing $167,000 loss.

Fire Fighting in Africa.

By Helen M. Powell.*

When one has been brought up in an atmosphere of fire protection all of one's life, it is natural to become fire protection conscious. That, coupled with the desire to see how the other fellow does things, has resulted in many interesting moments, and a good deal of worth while information.

In very few cases, I imagine, does the word Africa paint mental pictures of up-to-date fire stations and progressive ideas on fire protection. Yet Nairobi, the capital of Kenya Colony, Britist East Africa, boasts a modern, up and coming fire brigade that could easily compete with its fellow fire fighters so many miles across the world.

Every country has its mutual and individual fire problems. Perhaps Kenya's are more complex than others, due to the vast native population that must be educated to a constructive attitude regarding fire.

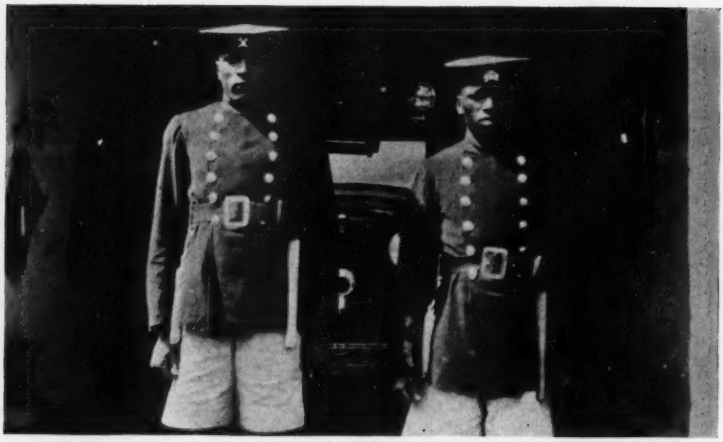
Just before the rainy season the natives become natural incendiaries through the desire to "better" their reserves for grazing. They do this by haphazardly burning away the bush and long, dry grass, so that the young green shoots can be seen. Far from achieving the desired results, they not only cause inestimable damage to their land, the forests and surrounding farms, but cause a problem of soil erosion that now must be coped with by the Kenya government.

In the reserves the approach of a fire is sometimes heralded by the game, which abounds on this land, stampeding by the thousands, very often before the fire itself can be seen. Unfortunately, the human mind is not equipped with the capacity for sensing this danger, and the blaze, with a sixty-mile wind back of it, strikes without warning.

Little nude, pot-bellied native boys, herding cattle all day long over the rolling countryside, are often trapped. In their efforts to drive their cattle away from the inferno rapidly advancing towards them, they are overcome by the yellow acrid smoke and drop into the flame.

A sudden change of wind and the fire is headed for the dense forests. Many years ago, when the white man was first settling in Kenya, a large forest in the highlands, comprised of cedar trees and heavy undergrowth, caught fire. It is estimated to have taken nearly a year to burn out completely. Today it is known as the Burnt Forest. The time taken to drive through it in a car is roughly four hours. In most cases, however, it does not take long for

*Mrs. Powell is the daughter of Harold L. Miner, past-president N.F.P.A. She recently removed to Kenya Colony.



Fourteen native firemen in Nairobi, Kenya Colony, Africa, are under the direction of three white officers. On either side of the engines, along the walls, are pegs holding the firemen's coats and glistening brass fire helmets. Beneath each coat stands a scrupulously polished pair of boots.

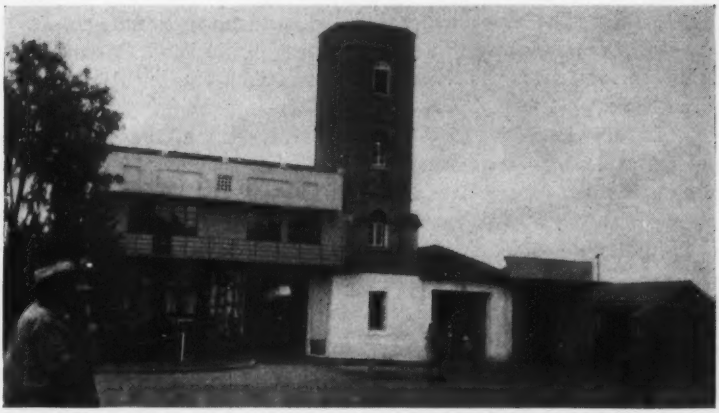
the majestic beauty of the land to be reduced to a mass of smoldering ash. Although reforestation is continually in progress, nothing can completely replace the gracefulness of nature's pattern.

The farmer must keep ever on the alert for signs of fire, or a whole life's work can be wiped out by one spark. The large areas under cultivation are latticed with fire breaks in an effort to reduce to a minimum the possibility of total loss.

Each land owner has his own set of fire regulations to control the native. The recruited laborers gather in small villages on the land and their living accommodations must be built certain distances apart to prevent conflagrations should one of the huts catch fire.

It is a long, arduous task to teach the native to regard fire in its proper light and not be wantonly destructive with its use. Vindictiveness seems to be one of the more prominent characteristics in the native mind, and fire has been its tool with drastic consequences. The native hut built of mud, with its dry thatched roof, once set alight offers no way of escape to those trapped within. What better way, reasons the native, to do away with enemies than to trap them in their flimsy homes? Steps are now being taken to control this "firebug," and in Uganda, the British protectorate just north of Kenya Colony, the penalty is life imprisonment for anyone caught setting a fire maliciously.

Paradoxically enough, natives, who must be trained in the reserve, are doing the fire fighting in the city. Nairobi's fire department consists of fourteen native firemen, supervised by three white men headed by the fire



The spotless modern fire station in Nairobi, Africa, is centrally located to protect the 46,000 residents. The station houses two American-made fire trucks and an ambulance. The fire tower affords a good view of the city.

brigade superintendent. The inhabitants of Nairobi total 46,000, and of these just over 6,000 are whites.

At the present time the Indian quarters of the town are the most in need of continual surveillance. The small, overcrowded, musty smelling shops and the too-compact housing make them a fireman's nightmare. Gradually, however, these residences are being demolished to make way for a rapidly growing forward moving city.

The spotlessly white fire house of modern architecture is situated, appropriately enough, in the center of this section of the town. The location is central, however, for all districts, and the fire tower affords a good view of the city. The fire brigade superintendent's living quarters are on the second floor of the fire house, and the surrounding garden contains, besides flowers, peach, banana and other fruit trees, a neatly trimmed grape arbor having luscious looking purple grapes. In fact, the only thing that proves it is a fire house and not just a private residence is the conspicuous position held by two fire engines of American manufacture, and an ambulance. The ambulance is a recently acquired addition to the fire station's equipment, notably more up to date than its predecessors.

One truck carries a hand-worked ladder with a seventy-five foot elevation. The other has a thirty-five foot ladder escape. The engines are housed in garages separated by a small room that opens on to each garage, and holds the open circuit fire alarm board, a through connection with police headquarters, a telephone to receive outside calls, and a prominently displayed list of all fire hazards and their locations.

On either side of the engines, along the walls, are pegs containing the firemen's coats (equipped with sheathed hatchets attached to belts) and glistening brass fire helmets, while beneath each coat stands a scrupulously polished pair of boots.

A monthly inspection of all building premises is conducted. A fire drill is held by the firemen every afternoon at five-thirty. The time taken for the men to be on the road after an alarm comes in has been clocked at thirty seconds. During the first five months of this year the fire department has had only twenty-three calls, none of which were serious fires.

What One Architect Thinks About N.F.P.A.

By Robert D. Kohn, F.A.I.A.,

Past-President, American Institute of Architects, Past-President National Fire Protection Association, Past President New York Building Congress, etc.

At one time I had been president of so many professional and industry organizations that my favorite governor, the famous Al Smith, saluted me at a public meeting as "Messrs. President"! But despite my weakness for collecting presidencies and chairmanships, I look back on my terms of service in various causes with an almost universal feeling of thankfulness for the opportunities offered. It seems to me that I always sought or accepted each of these responsibilities because I thought I ought to advance some much needed reform. I considered it a sacrifice. And I am equally certain that I finished each such term of office with the conviction that I had received more than I had given, for I profited enormously in human understanding plus technical knowledge from the contact they afforded. My association with the National Fire Protection Association as President and the later years of more passive affiliation are not the least of these experiences of receiving more than was given.

Quite frankly I was a bit suspicious of the N.F.P.A. twenty-five or thirty years ago when I first heard of it. There were so many members in it whose interest was so evidently the improvement of standards of building in order to decrease the risk of spread of fire and consequent fire loss. But before long I realized that its selfish backing was an enlightened self-interest, and the organization included a large group of absolutely disinterested, purely professional technicians and research men. These were just as interested in reducing the hazards to life from fire as were the doctors in improving public health (even if thereby, incidentally, they benefit the life insurance companies). And right here I want to pay a tribute to these members of the N.F.P.A. whom it was my privilege to know—the men in the Underwriters' Laboratories, the officers and directors of the N.F.P.A., and the men working year after year on the innumer-

able committees of the Association. It seemed to me that in their field they had a pride of craftsmanship in their everyday work which ranks with that of the best men in any profession I know.

But I started this brief article to tell my fellow architects who are not now connected with the National Fire Protection Association how much some of them might profit by joining it. Of course, the Institute of Architects has long been a constituent member. But as an individual member, its publications have been coming to me right along for years, and merely glancing through to see what interested me has given me important knowledge of new methods of protection, sometimes markedly affecting advice I gave to my clients. I am sure that many of the changes I suggested did not imply much if any increased cost in construction. The publications of the Association have always been a sort of "teaser" to remind me periodically of the architect's share in the responsibility for the neglect resulting in the annual fire loss of life and money. I like to think that ours is only a minor share and that the major trouble lies at the door of the indifferent "speculative" builder. And yet we are the trained "doctors" in the field of building construction and it is our responsibility to give sound advice to our clients as to the permanent health of their structures whether the clients like our medicine or not. And they *will* like the medicine when they realize that its results will pay in more senses than one.

One more thing I am going to say as an architect to other architects only! Most of them know it, but it is worth repeating for the rest. At first blush some of the rules of the game, I mean the requirements of fire-safe building, interfere with that expression of our aesthetic conception of a solution to a design problem which every worth while architect considers as all important. Well, just let's think it over. Twenty or thirty years ago it was considered essential to have wide-open stairs and open elevator shafts from floor to floor; ornamental grand staircases and wrought iron open grilles all around elevators. What do we think now? Only a few years ago a well-known "classic tradition" architect built a high college building with its elevators stopping one story short of the top floor because he would not allow the elevator shaft to show above the sloping roof! But we have found perfectly good artistic expressions for elevator top houses, and tanks properly housed above the roofs of modern buildings, and stairs enclosed throughout buildings, and the day is forever over when modern functions will be squeezed into Greek or Roman forms.

Which brings me back to the objects of my little diatribe; namely, to pay tribute to the National Fire Protection Association as an educational agency, to express my own indebtedness to its excellent group of coöperating technicians and specialists, and to tell architects generally that even if they are a great deal wiser than I am (and all the youngsters certainly are) they can gain a lot from membership in the N.F.P.A.

Fire Tests of Treated Wood Partitions.*

By Clement R. Brown,
National Bureau of Standards.

Recent interest in the use of fire-retardant treated wood has revived the demand for reliable methods of classifying such material both in terms of its resistance to fire and its fire hazard compared to that of untreated wood. Several testing methods for this purpose have been studied and employed during the past few years.

The fire resistance of structural elements is usually determined by fire tests of relatively large specimens. These tests indicate the ability of a given type of construction to sustain a load when exposed to fire, to prevent the occurrence of unduly high temperatures on the unexposed side, and to retard the passage of flame or hot gases through the construction. Although occasionally applied to floors, partitions and doors constructed of treated wood, tests of this type have usually not been carried to failure of the structure, nor have they permitted direct comparisons between treated and untreated wood.

Those properties relating to fire hazard, such as combustibility and the tendency to spread fire, are mostly determined by laboratory tests on small specimens, including the fire-tube and flame-penetration tests. The flame-penetration tests are also intended to give information on the ability of a material to retard the passage of flame.

In a recent investigation by the National Bureau of Standards an attempt was made to correlate the results of the three types of test, and to obtain from them a definite indication of the value of fire-retardant treatments for wood. Complete panels of practical construction were used in the fire-endurance tests, and small samples from the stock from which the panels were made were tested by the fire-tube and flame-penetration methods.

Material and Treatment.

For the fire-endurance tests, thirteen panels, four feet square, were constructed of southern yellow pine in various cross sectional designs. The only treatment used was mono-ammonium phosphate and its concentration was known for each panel. Similar tests were also made on four large partitions (10 by 16 ft.) constructed of fire-retardant treated birch by a commercial woodworking and treating concern. The actual concentration of treatment on the birch panels was not known, but was believed to be high.

NOTE: This account is abstracted from Research Paper RP1076, part of the *Journal of Research* of the National Bureau of Standards, Volume 20, which gives a complete technical record of this research.

*Publication approved by the Director of the National Bureau of Standards of the U. S. Department of Commerce.

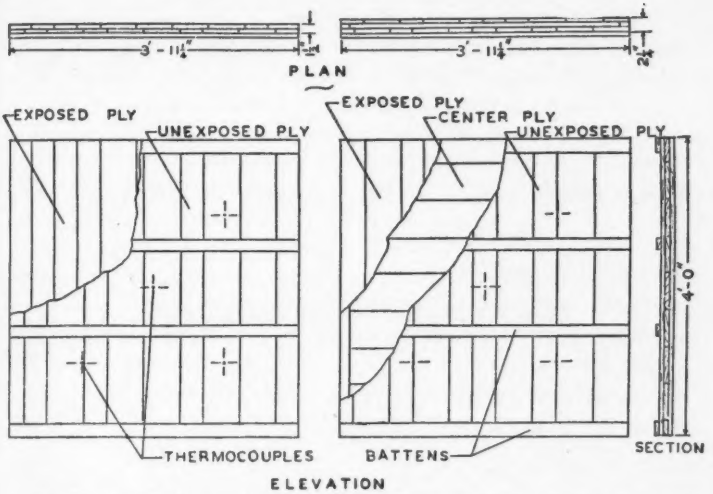


Figure A. Construction of two-ply and three-ply pine panels used in fire endurance tests. The other three-ply panel (10) had vertical centre-ply boards.

Ten of the pine panels were constructed in plies, and the other three consisted of a thick core faced with veneers. The panels consisting of plies were built in the shop of the Bureau, with each board carefully selected in order to give the same concentration of treatment throughout the panel. The boards were all carefully planed, tongued and grooved so as to insure tight joints. No glue was used in the joints or between the plies. The plies were held together with nails and nailed batten strips across the side which was not to be exposed to fire. Panels having more than one ply were equipped with fine wire thermocouples between the plies. Figure A shows the construction of the ply panels.

All joints were glued in the pine core and veneer panels, and the veneer was glued to the core under pressure. The large birch panels were made in sections connected through tongued and grooved joints to prevent the passage of smoke and flame. All joints were also glued in these large partitions. In one of them, however, a flush type door was placed in one of the sections, the construction of the door being similar to that of the rest of the panel. It was hung to open toward the side to be exposed to the fire. The edges of the door were beveled and the beveled door jambs were tongued on the back so as to fit into corresponding grooves in the adjacent panel sections. The thicknesses of core and crossbanding used in the birch panels were varied slightly in order to obtain the desired variation in total thickness of the panel. The construction of the small and large core and veneer panels is shown in Figures B and C respectively.

Test Procedure.

Each of the panels was mounted in turn in a frame in front of a gas fired furnace, every precaution being taken to secure a tight joint between the panel and the frame. Temperatures in the furnace during the test of all but one of the panels were gradually increased, corresponding as closely as possible with the Standard Time-temperature Curve. Temperatures were measured during the tests by thermocouples inside the furnace, between the plies of the ply

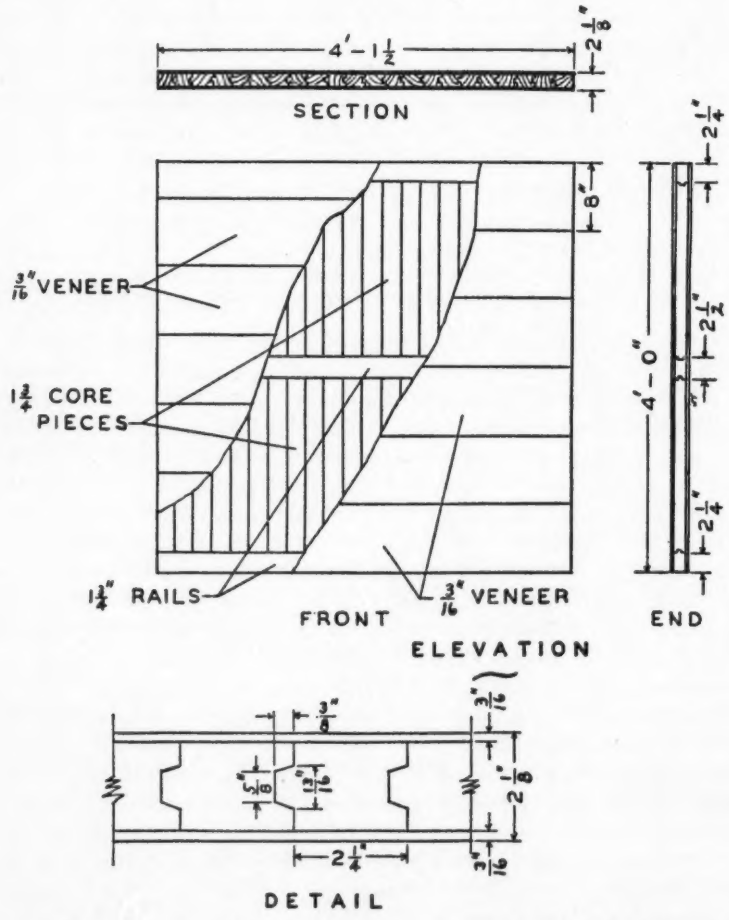


Figure B. Construction of core and veneer pine panels used in fire endurance tests.

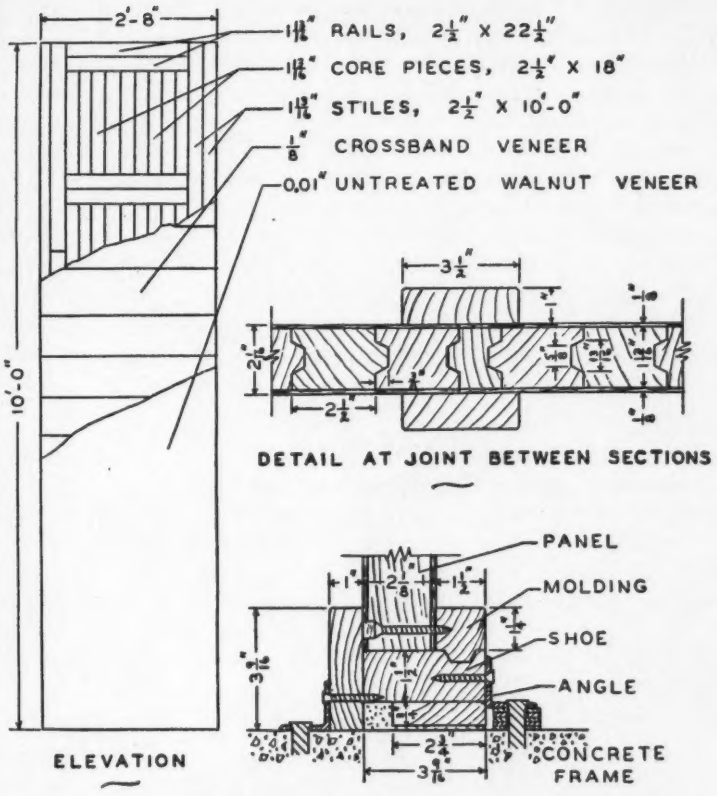


Figure C. Construction of sections of large birch panels for the fire endurance tests. Each panel consisted of six such sections. One panel (B) was equipped with a door.

panels, and on the unexposed surface of all panels. On some panels the temperatures of the unexposed side were also read from thermometers. One of the birch panels (B)* was tested according to the specifications for the first half hour. The temperatures were then increased more rapidly in an attempt to obtain an average exposure of 1700° F. for the last half hour.

Observations taken during the tests included: The temperature in the furnace, the temperature on the unexposed surface, the time required for any

*See Table of Results for panel numbers.

crack to open and admit light from the furnace to the unexposed side of the panel, and the time to failure. In the panels of more than one ply, temperature readings were also taken from the thermocouples between the plies.

In conducting the test the criterion of failure was taken as any one of the following: An average temperature rise of 250° F. (139° C.) above the initial, as shown by the surface thermocouples; a maximum temperature rise of 325° F. (181° C.) above the initial at any one surface thermocouple location; or the appearance of flame on the unexposed surface. The test was discontinued shortly after any one of the above endpoints was reached.

All of the tests were fire-endurance tests except that on the large panel, which was equipped with a door. This was a fire test for ½ hour, immediately after which the panel was withdrawn from the furnace and subjected to a hose stream applied for 2 min. 24 sec.

Results of Tests.

Small Panels.

Figure 1 shows the temperature curves of two treated and one untreated two-ply panels compared with a treated core and veneer panel. The behavior of the ply panels (1 to 10) was very similar except for the amount and character of flaming. The exposed surface was charred and began checking within the first 2 minutes, and the joints in the ply nearest the fire began opening at from 9 to 18 minutes. Short pieces of the boards of this ply began falling off the panel at from 21 to 25 minutes, and most of the ply had fallen off within the next 5 or 6 minutes. This was followed by warping and opening of joints

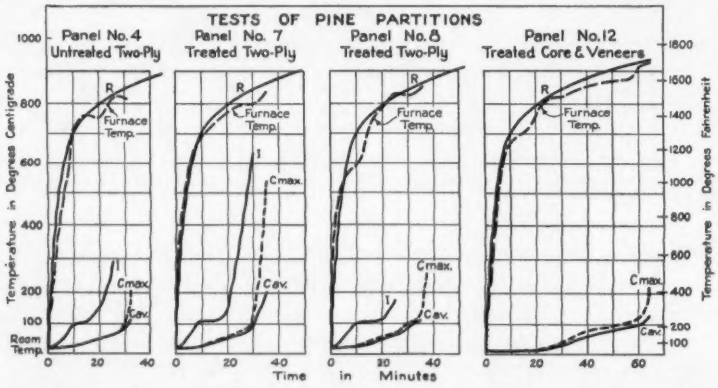
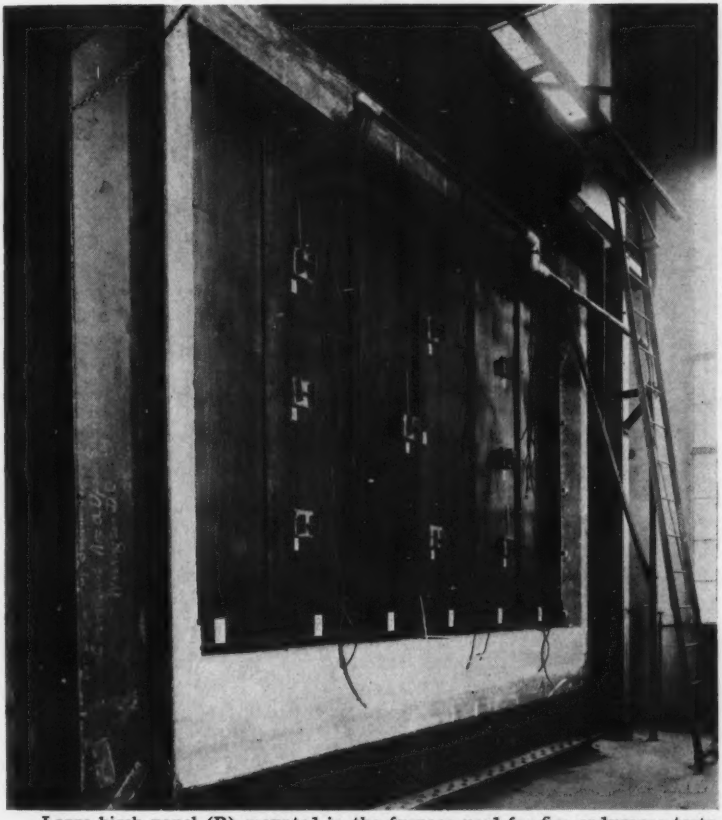


Figure 1. Temperature records of fire tests of four pine partitions. The furnace temperature was regulated to coincide as closely as possible with the standard time-temperature curve, marked "R." The curve marked "I" records the temperature readings of between ply thermocouples on the two-ply panels; C max. and C av. indicate the maximum and average, unexposed surface, thermocouple readings during the tests.



Large birch panel (B) mounted in the furnace used for fire endurance tests. Note the spacing of the thermocouples to indicate surface temperatures.

in the adjacent ply. In the case of the three-ply panels (9 and 10) the core boards began falling off at 34 and 36 minutes, respectively. The time at which the joints in the unexposed ply had opened sufficiently to permit light from the furnace to be seen is given in the Table of Results.

For the untreated panels, periods of vigorous active flaming alternated with periods of subdued flaming during fire exposure. The flaming during the exposure of the moderately treated panels, 2, 5, 6, 9 and 10, was sometimes similar to that for the untreated panels, but less intense. At other times the flames were of the short, greenish-blue variety characteristic of wood treated with mono-ammonium phosphate. These colored flames predominated entirely in the tests of the heavily treated panels, 7 and 8, and it was sometimes difficult to maintain good combustion in the furnace.

The untreated panels, 1, 3 and 4, continued flaming actively after the test and were almost entirely consumed in about 15 minutes more. The single ply treated panel, 2, failed in less than 10 minutes and ceased glowing and flaming shortly after the gas was shut off, all boards remaining in place. The other moderately treated panels continued to burn for as much as an hour after the test, but the flames were less active than in the case of the untreated wood. A slight amount of glowing and flaming of the heavily treated panels after fire exposure was confined mostly to such spaces as those in back of battens. The destruction of these panels was very slow and incomplete, and some boards were only partially charred on the side not exposed to fire.

In tests of core and veneer panels, the joints in the veneer on the unexposed side began opening at about 40 minutes, and flame had come through the panel before much of the core had fallen. While very little flaming was noted during the test of the well-treated panels, 12 and 13, a surprisingly large amount of active flaming occurred after fire exposure of these panels and they were destroyed rather quickly. This may have been caused by the presence of the relatively thin veneer, although it was well treated.

Large Panels.

In the tests of the large birch panels (A, B, C and D) the thin untreated veneer on the exposed surface burned off within 2 minutes and the treated crossbanding began falling off shortly afterwards. This was followed by checking of the battens and core in 1 or 2 inch squares. As charring proceeded, layers of charred material fell off the battens and core, and although small pieces of the core were continually falling off, the treated crossbanding on the unexposed side was not exposed to fire until from 47 to 63 minutes after the start of the test. The combustion conditions during the first part of the test of panel A were poor; apparently because of the introduction of an excess amount of gas fuel. There was very little flaming from the panel and most of it was in the central and lower portions. In the tests of the other large panels more flaming of the exposed side was noted.

During the first half hour small quantities of a dense, white smoke were occasionally noted coming from under the battens and marginal pieces on the unexposed side. After this period very little smoke was noted until failure was imminent. Shiny spots having an oily appearance began to show on the unexposed surface after 35 minutes. Warping of this surface and apparent buckling of the panel were first noted at about 45 minutes. Failure by flame penetration was preceded by the appearance of a blister on the unexposed surface, which soon turned black and then cracked, glow or flame appearing a few minutes later. In the case of panel A, glow appeared on the surface at 62 minutes, and a cotton pad held in contact with the glowing surface was ignited. This time was taken as failure, although flame did not appear until several minutes later.

Appearance of large birch panel (B) after exposure in fire endurance test. Only one of the joint battens (right) has been burned out.

Intermittent flaming at various points on the unexposed surface continued for about 10 or 12 minutes after fire exposure of panels A, B and C, although glow and short flames were noted in the interior and behind battens and marginal pieces for several hours. Disintegration of the core and crossbanding proceeded rapidly during this period, undoubtedly being aided by heat rising from burning débris in the furnace pit and also radiation from the back wall of the furnace. After cooling, approximately two-thirds of the unexposed surface of panel A, and about one-third of this surface of panels B and C, were still in place.

During the fire exposure of panel D, smoke was seen to be issuing in small quantities from several points along the edges of the door within the first

Table of Results.

Panel	Total Thickness, Inches	Treatment Per Cent	Fire-Endurance Tests. Cracks Opened, Minutes	Fire-Endurance Tests. Time of Failure, Minutes*	Fire-Tube Tests. Max. Temp. Deg. C.	Fire-Tube Tests. Weight Loss, Per Cent	Fire-Tube Tests. Max. Rate of Weight Loss, Gms. per Min.	Flame-Penetration Tests. Cracks Opened Minutes	Flame-Penetration Tests. Flame Penetration, Minutes	Flame-Penetration Tests. Av. Rate of Weight Loss, Gms. per Min.
Pine										
1. One-ply	¾	None	8.3	8.9 F	743	83	31.9	8.0	9.0	5.62
2. One-ply	¾	8.2	7.2	9.4 F	708	59	26.7	12.7	17.2	3.83
3. Two-ply	1½	None	28.5	29.4 F	724	83	29.4	40.7	42.8	5.98
4. Two-ply	1½	None	30.0	32.3 T	731	83	31.8	36.3	38.9	6.98
5. Two-ply	1½	6.9	29.0	30.5 T	460	49	19.4	36.2	41.8	3.64
6. Two-ply	1½	8.2	27.4	28.3 T	387	44	16.1	35.0	40.6	4.39
7. Two-ply	1½	15.9	30.0	31.5 T	183	19	7.5	56.2	62.3	2.90
8. Two-ply	1½	15.9	31.5	34.5 F	174	18	7.2	56.4	63.5	2.92
9. Three-ply	2¼	8.3	37.8	40.5 F	390	40	14.0	95.6	113.7	3.52
10. Three-ply	2¼	8.6	42.2	45.3 F	306	38	13.2	92.2	101.2	3.38
11. Core and veneers	2⅛	None	63.3	67.0 T	707	84	32.6	55.6	60.6	6.48
12. Core and veneers	2⅛	17.0	59.2	62.9 F	179	19	7.0	93.6	100.6	2.92
13. Core and veneers	2⅛	17.2	68.4	72.1 F	180	18	7.0	90.4	95.0	3.61
Birch										
A. Core and veneers	2 1/16	High	62.0	62.0 G		Not tested			Not tested	
B. Core and veneers	2 3/16	High	...	64.5 F		Not tested			Not tested	
C. Core and veneers	2⅛	High	61.0	61.5 F	163	14	6.2		Not tested	
D. Core and veneers	2⅛	High	Not continued		192	26	10.6		Not tested	

*Cause of failure indicated by "F," "G" and "T."
F: Flame on surface.
G: Glow on surface.
T: Limiting temperature exceeded.

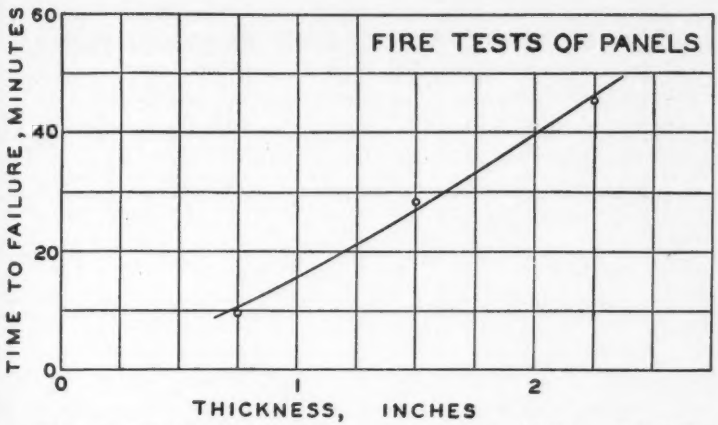


Figure 2. Effect of thickness of pine panels on time of failure. (Panels Nos. 2, 6 and 10.)

few minutes, and again at 12 minutes, when the air pressure in the furnace was momentarily increased above normal. After 22 minutes smoke began coming from the top edge of the door in regular puffs and increased in volume until the end of the test. The maximum clearance on this edge increased from ¼ inch at 19 minutes to nearly ½ inch at 26 minutes. Immediately after shutting off the gas, the panel was removed and a hose stream applied to the exposed side. Water came over the top of the door and ran down the unexposed side, and the force of the stream caused some loose pieces of charred core and nearly all battens on the exposed side to fall off, but the stream did not penetrate the core.

When this panel was dismantled, it was found that the screws holding the door hinges were all loose, and the door was pulled out of place without much difficulty. Charring had extended to the unexposed side along a portion of the top edge of the door and also on the inside edge from the upper hinge to the top. The door jambs and stops were also charred to the greatest extent on those surfaces adjacent to hardware. For the most part, the depth of char in the central portions of the door, as well as each panel section, was less than half the thickness of the panel.

Discussion of Results.

The principal quantitative result obtained in the fire-endurance test is the time of failure. The small panels differed chiefly in thickness, amount of treatment, and type of construction. Figure 2 shows the relation between the time of failure and thickness for panels 2, 6 and 10, which were comparable in construction and concentration of treatment. This relation is practically linear. In non-combustible walls and partitions, the fire endurance increases

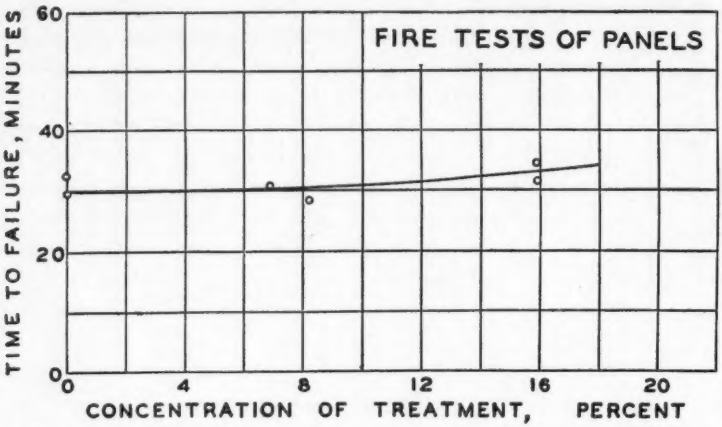


Figure 3. Effect of concentration of treatment on time of failure of two-ply panels. (Panels Nos. 3 to 8 inclusive.)

approximately with the square of the thickness. From Figure 3 it is evident that concentration of treatment has very little (if any) effect on the time of failure in this particular type of test, at least in the range from 0 to 16 per cent. Also the untreated core and crossband panel 11 developed nearly the same fire endurance as the average for the heavily treated panels 12 and 13 of similar construction. This may not necessarily hold for other species of wood or other treatments. On the other hand, the type of construction is an important factor. The performance of the core and crossband panels 11, 12 and 13 was much better than that of the ply panels 9 and 10, which had slightly greater thickness.

The large panels differed too little to permit a study of such factors as thickness and type of construction. They were similar in construction and thickness to small panels 11, 12 and 13, and although they were of different wood species and treatment there was very little difference between the results of the tests. It appears that size of specimen in the range included does not greatly affect the fire endurance of wood partitions of this type of construction.

The standard fire-test specification states that assemblies which burn freely during fire exposure or continue flaming after the furnace is shut off shall be termed "combustible." Therefore all of the 17 panels tested would be classed as "combustible" under the standard fire-test specification.

The standard fire-endurance test used in this work is based on the application of temperatures on one side of the partition which increase with time according to a prescribed schedule. In the case of a partition made up entirely of non-combustible materials, all of the heat required to maintain these temperatures is necessarily supplied by the gas or other fuel used in the furnace.

In the case of partitions built wholly or in part of combustible materials, however, some heat is supplied by the combustion of these materials. Consequently, in maintaining the same exposure temperatures, the amount of furnace fuel is reduced to compensate for this heat. The exposure given the combustible type of partition is thus less severe than it would be if the test required a definite amount of furnace fuel to be burned in a given time rather than the maintenance of a certain time-temperature relationship.

In these tests failure of both treated and untreated wood partitions was obtained in approximately equal periods of time, but probably with the supply of greater amounts of gas fuel in the tests of the treated wood partitions. In evaluating the performance to be expected from partitions such as these in an actual fire, the relative amounts of fuel supplied to maintain the same temperature rise within the furnace may be significant.

In the design of buildings, the fire-resistance ratings of the different members are determined by the expected severity of fires that can occur in the given location. Hence, in estimating such fire severities, account should be taken of any combustible content of the partition selected as a barrier to fire, as well as the amount of combustibles within the building, such as furniture and other contents, and in other building members.

Fire-Tube and Flame-Penetration Specimens.

For each of the small panels tested, three specimens for the flame-penetration test and five or six specimens for the fire-tube test were prepared from the material remaining after construction of the panel. Several fire-tube specimens

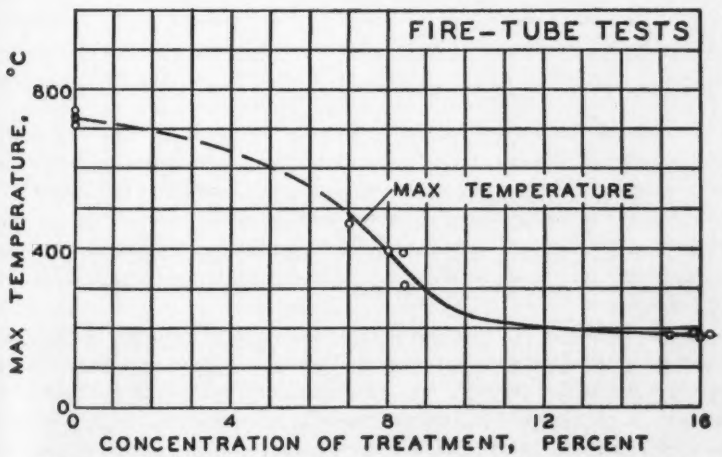


Figure 4. Effect of concentration of treatment on maximum temperature in fire tube tests.

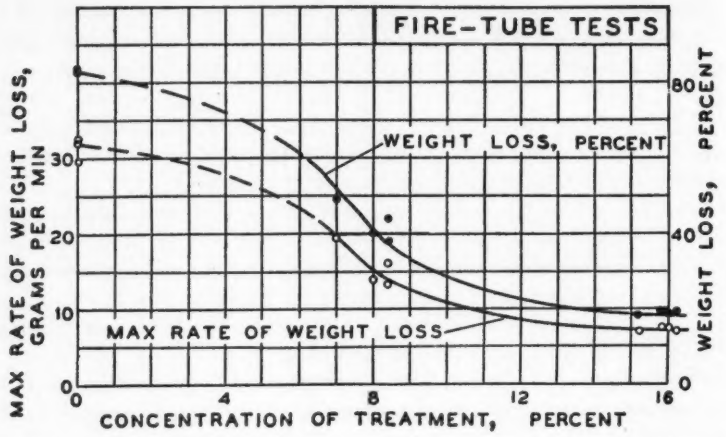


Figure 5. Effect of concentration of treatment on weight loss and maximum rate of weight loss in fire-tube tests.

representative of the treated birch used in the large panels were also obtained at the time of their construction. The specimens for the flame-penetration test were about 10 inches square and of the same thickness and type of construction as the corresponding panel, being made from the ends of boards and splines cut off during the construction of the panels.

Fire-Tube Tests.

The fire tube, developed by the Forest Products Laboratory, U. S. Department of Agriculture, is a sheet metal tube about 50 inches long, which is suspended from one arm of a balance beam. The lower end of the tube is enlarged and has screened sides and a solid bottom. Adjustable weights are placed on the other end of the beam to counterbalance the weight of the tube and specimen before test. A pointer attached to the center of the beam indicates the loss in weight during the test. Temperatures are measured at the top of the tube by means of a thermocouple. A slot in the lower end of the tube permits the insertion of a low form of bunsen burner. The flame of this burner, with its tall indistinct inner cone, is adjusted to give a temperature of 180° C. at the top of the tube.

In conducting a test the beam weights and scale are adjusted so that the pointer indicates 0 per cent loss with the specimen in place and 100 per cent loss when the tube is empty. After a preliminary heating of the tube, the specimen, $\frac{3}{8}$ by $\frac{3}{4}$ by 40 inches, previously conditioned and weighed, is suspended centrally in the tube. The bunsen burner is then inserted about one inch below the lower end of the specimen and readings of temperature and loss

in weight are taken at frequent intervals. The burner is removed at the end of 4 minutes and the readings are continued until 2 minutes after all flaming has ceased. Subsequently, the temperature and weight loss data are plotted against time.

The results of the fire-tube tests are given in the table. All figures are averages for the tests performed. The maximum temperature is the average of the maximums recorded in individual tests. The maximum rate of weight loss was calculated on the basis of the greatest loss in weight for a single minute occurring during the test.

The relations between some of the results obtained in the fire-tube test and the concentration of treatment for the specimens tested are given in Figures 4 and 5. The dashed portions of the curves have been filled in from results previously obtained using less heavily treated specimens. Figures 4 and 5 leave little doubt of the distinct effect of treatment in this type of test, especially where the treatment is 8 per cent or more. No specimen more heavily treated than 8 per cent continued flaming after the burner was removed.

Flame-Penetration Tests.

In the flame-penetration tests the specimens were supported in a horizontal position so that their centers were three inches above the tip of a three-eighths inch tirrill burner. The gas flow was adjusted to about 3000 B.t.u. per hour. A thermocouple was located at the center of the top surface of the specimen and temperature readings taken at frequent intervals. Other data taken in-

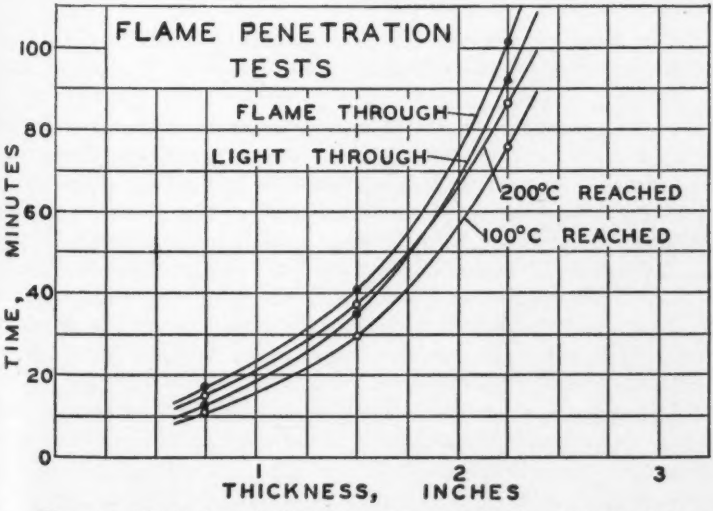


Figure 6. Effect of panel thickness on flame penetration and other time results. (Panels Nos. 2, 6 and 10.)

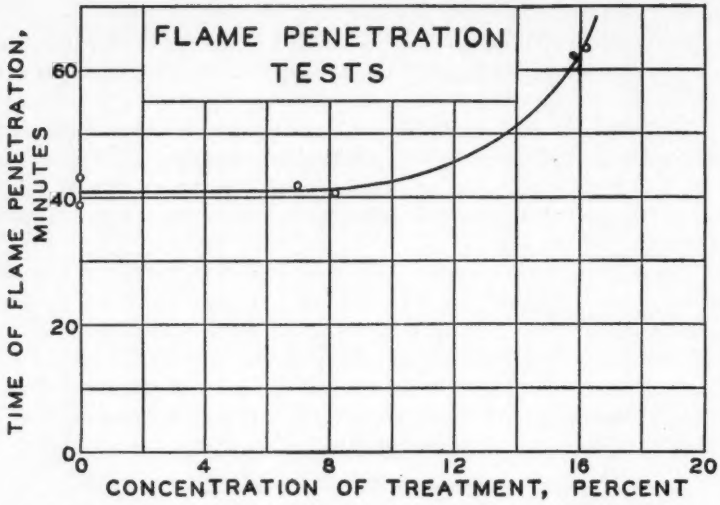


Figure 7. Effect of concentration of treatment on time of flame penetration. (Panels Nos. 3 to 8 inclusive.)

cluded time for light to come through any crack, time of flame penetration, time of ignition on the top surface, duration of flaming, and loss in weight. If ignition did not occur within five minutes after flame penetration, the burner was removed.

In the results the rate of weight loss was found by dividing the total loss in weight by the total duration of flaming, including the time of burner application.

The flame-penetration specimens were varied in the same respects as the panels, that is, in thickness, concentration of treatment and type of construction. Referring to Figure 6, it is seen that the time to flame penetration increases rapidly as thickness of the specimen increases for panels 2, 6 and 10, which are comparable in amount of treatment and construction. The time to flame penetration (see Figure 7) does not appear to be greater for moderately treated specimens than for untreated specimens, but is much greater for the well-treated specimens. On the other hand, the rate of weight loss decreased more rapidly with increasing amount of treatment in the range of low concentration than in the range of high concentration, as shown in Figure 8. The specimens for panels 12 and 13 did not show the increased resistance to flame penetration over those for panels 9 and 10 to be expected from the increased concentration of treatment and type of construction, although the average weight-loss results were lower. This might be attributable to the fact that there was always a joint in the core at the center of the specimens for panels 12 and

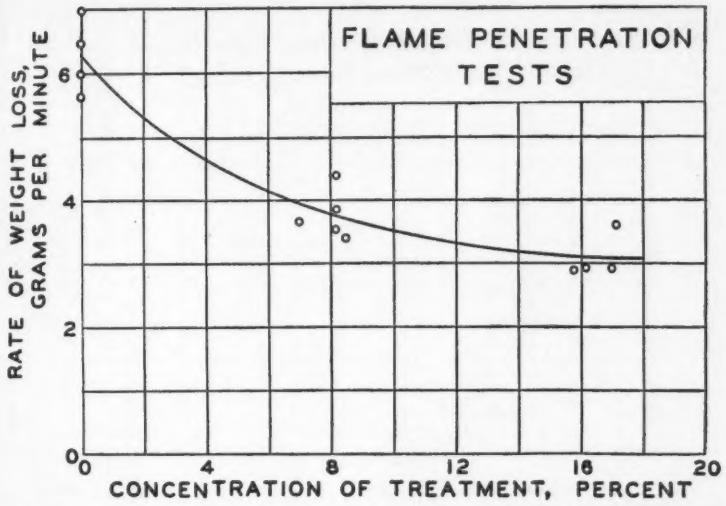


Figure 8. Effect of concentration of treatment on rate of weight loss. (Pine panels.)

13 and hence directly over the burner flame, while such was seldom the case for the three-ply specimens.

Comparison of Results.

Although the fire-endurance test did not reveal the concentration of treatment as an important factor in the fire resistance of panels, that same treatment seemed to have a most important influence on all of the results of the fire-tube tests. Hence the fire-tube test, which is a test of materials and not of structure, cannot serve to predict the fire resistance of such panels, but only to indicate qualitatively the amount and character of flaming during and after fire exposure. The same can be said of the rate of weight loss in the flame-penetration test.

Figure 9 shows the relation between the time of failure in the fire-endurance test and the time of flame penetration in the flame-penetration test. This relation is limited, since the concentration of chemicals in the wood has no important influence on fire endurance, although high concentration is important in the time of flame penetration, and because of the contradictory influence of the type of construction on the results of the two tests. There are also differences in the nature of exposure. In the fire-endurance test, practically the entire surface of one side of a very large specimen is exposed to furnace temperatures. The fuel supplied to the furnace is constantly adjusted so that the furnace temperatures follow a definite curve. The exposure is severe, and any part of the structure having poor fire resistance can hardly escape the test and

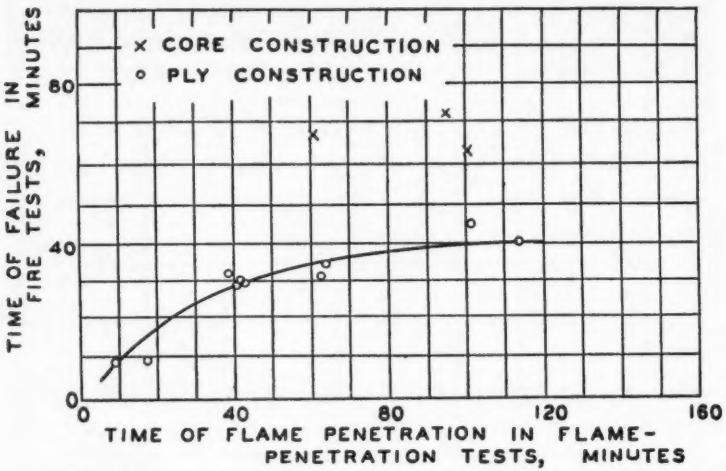


Figure 9. Relation between time of flame penetration in flame-penetration tests and time of failure in fire tests.

is most likely to be the place of failure. On the other hand, only a small portion of a small sample is subjected to the direct flame of a burner in the flame-penetration test. The fuel is supplied at a constant rate. The exposure temperature is therefore influenced by the combustibility of the material being tested. The exposure is not so severe as in the fire test, and even with the use of several samples, the poorest parts of the structure, such as joints, may not be tested. These differences in the two tests may explain the differences in the results.

Finally, there is apparently a general relation between the rates of weight loss in the fire tube test and the flame-penetration test, as shown in Figure 10.

Summary and Conclusions.

The principal conclusions to be drawn from the fire tests of partitions, the flame-penetration, and the fire-tube tests on representative specimens of the same materials are:

1. As measured by the standard fire-endurance test, concentration of treatment apparently has little effect on the fire endurance of partitions built of longleaf pine treated with mono-ammonium phosphate, the fire-endurance periods of two-ply panels, 1½ inches thick, ranging from 28 to 35 minutes, and of 2⅛-inch core and veneer type panels, from 63 to 72 minutes, irrespective of treatment.

2. Design and thickness are both important factors affecting the fire resistance. For the 2⅛ and 2¼-inch panels the fire endurance ranged from 40 to 72 minutes, depending mainly on design.

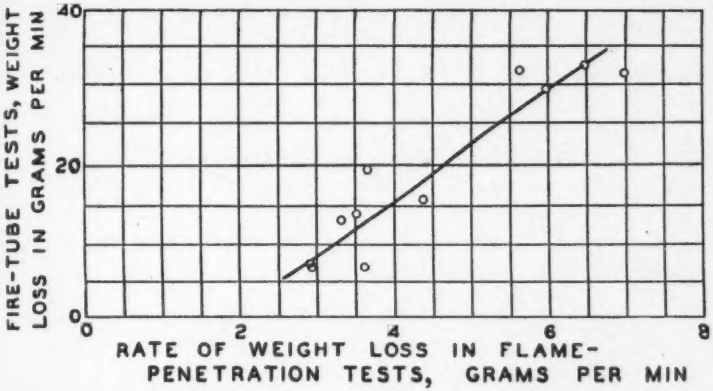


Figure 10. Relation between rate of weight loss in flame penetration tests and maximum rate of weight loss in fire-tube tests.

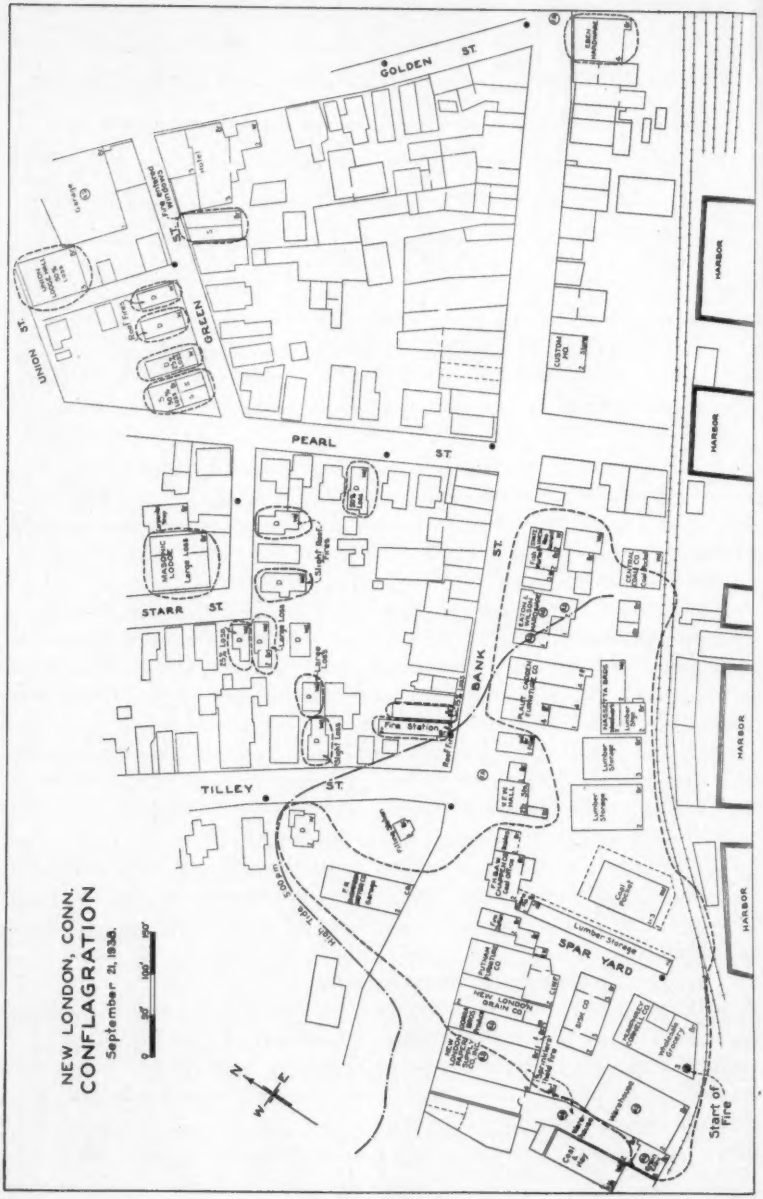
3. The results of the tests of three large treated birch panels, approximately 2⅛ inches thick, ranging from 62 to 64 minutes in fire endurance, compared with a range from 63 to 72 minutes for smaller longleaf pine panels of similar design and thickness, indicate that the effect of size of specimen in this range is not very important.

4. While all of the results of the fire-tube test are definitely related to the concentration of treatment, none of them appears to be related to the fire endurance of the partitions as determined in fire-endurance tests. The fire-tube tests, however, can be taken as indicating the tendency of wood to support combustion and spread fire.

5. The rate of weight loss obtained in the flame-penetration test varies with concentration of treatment in about the same manner as the corresponding figure in the fire-tube results, but the range is relatively smaller. It also has some value in indicating the degree of combustibility of wood.

6. The time of flame penetration varies directly with thickness of the specimen. It is affected by relatively high concentration of treatment, and also by type of construction, but not in the same way as the time of failure in the fire-endurance test.

7. There is a relation between the time of flame penetration in the flame-penetration test and time of failure in the fire-endurance test, but only for partitions of the same type of construction and, to some extent, for partitions of the same concentration of treatment. Accordingly, the flame-penetration test has only a limited value as an indication of the fire resistance of a wood partition, as determined by fire-endurance tests.


NEW LONDON, CONN.
CONFLAGRATION
September 21, 1938.
0 50' 100' 200'
GOLDEN ST.
UNION ST.
GREEN
PEARL ST.
STARR ST.
TILLEY ST.
BANK ST.
HARBOR
HARBOR
HARBOR
HARBOR
Fire Station
SPAR YARD
Lumber Storage
Start of Fire
N
E
W

New London, Connecticut, Conflagration.

Fire starting in a wholesale grocery warehouse at the waterfront of New London, Connecticut, during the height of the great hurricane of Wednesday, September 21, 1938, was driven by a wind at times reaching 100 miles an hour through a portion of the congested business district, causing a loss estimated at approximately $1,000,000. In addition to the main fire area, flying brands started many exposure fires in near-by residential streets. These additional fires greatly harassed the overtaxed fire fighting forces, which could obtain little assistance from outside the city because the storm had disrupted all means of communication and roads were blocked by fallen trees and débris.

More than fifty buildings were destroyed or damaged. These were of brick-joist and frame construction and from one to four stories in height. Several sprinklered properties were involved in the fire. A four-story sprinklered building, although considerably damaged, stopped the spread of the fire to the northwest, as shown by the accompanying map. After nearly seven hours' work a determined stand by the fire department checked the spread of the fire to the northeast.

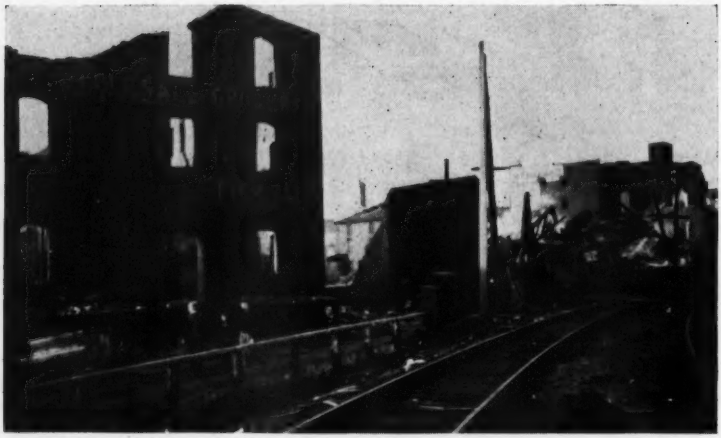
Probably no conflagration has been fought under more numerous handicaps. Not only did the hurricane break fire streams into little more than a bath spray and make hose lines immovable, but falling trees greatly delayed the response of the apparatus. All light and power services were cut off. Both fire alarm and telephone systems were out of service. Only foot messengers were able to get help from near-by towns. The local radio station was out of service. In addition, the extremely high tide at the height of the storm inundated much of the fire area.

Conditions at the Time of Origin.

New London was subjected to the full force of the hurricane which swept the greater part of New England on September 21, 1938. The barometer fell to 28.22 and wind gusts of 90 to 120 miles per hour were experienced during the height of the storm between 4 and 5 P.M. With the wind the tide rose to an unprecedented level so that in the fire area the water was as much as six feet in depth shortly after the fire started.

The New London fire department consists of six engine and hose companies, and two ladder companies. With the exception of the chief, deputy chief, and apparatus drivers the department is a volunteer force. At the time of the conflagration there was also in operation a New London County mutual aid plan.

NOTE: This report is based on an inspection of the conflagration area by N.F.P.A. engineers and a detailed investigation of the fire by Mr. P. E. Charnock, New England Fire Insurance Rating Association (Member N.F.P.A.).



The conflagration started in the wholesale grocery warehouse shown at the left. At the right may be seen ruins of a coal pocket, with the remains of the Plaut-Cadden Furniture Company warehouse in the background.

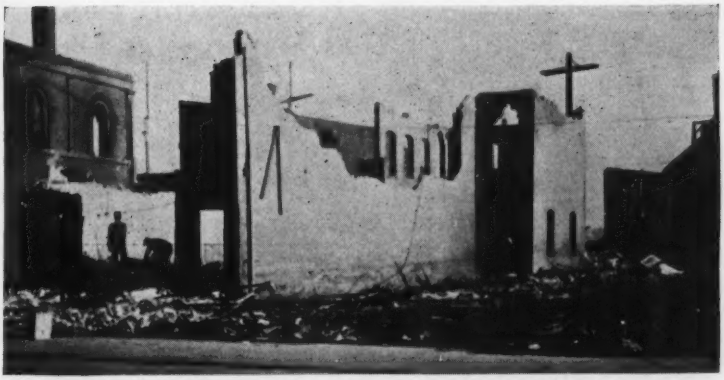
But for the interruption of communication by the hurricane, this plan would have automatically made available a total of fifty fire companies at the conflagration. As it was, comparatively little outside help was obtained and one of the five New London pumpers was unable to reach the fire.

Beginning at 2:06 P.M. blasts on the fire alarm whistle indicated the start of the hurricane. Trouble was experienced on all but one fire alarm circuit and conditions could not be corrected. From this time on the fire alarm system was out of service. An inter-station telephone system allowed the fire alarm operator to dispatch all the apparatus, but later went out of service.

As the storm increased there came a deluge of emergency calls for fire department assistance. These involved the removal of persons from endangered buildings, falling trees, chimneys, and other causes. Most attention was given to calls which appeared to involve a life hazard. Other calls answered involved broken sprinkler piping and collapsed buildings.

As the storm continued to increase, all apparatus was ordered back to quarters so as to be ready for a possible conflagration. Several companies had great difficulty in returning to their stations due to the débris and trees blocking the streets.

Before the start of the conflagration it was noted that the water pressure gauge showed a drop of approximately twenty pounds. This was due to broken piping caused by the collapse of various buildings and breakage of pipes in numerous waterfront cottages swept away by the storm. However, the fire department reported that throughout the conflagration there was no shortage of



Ruins of the fire department station at the corner of Bank and Sparyard Streets. It was from this station that the first alarm was sounded. Flood tides accompanying the storm made Sparyard Street impassable for fire fighting operations.

water for all the pumpers they were able to mobilize. This may be accounted for by the fact that the fire department was able to take suction from tide water in the street at several locations. Most of the hose lines were supplied by hydrants located on side streets, because hydrants on Sparyard and Bank Streets were mostly inaccessible due to the flood.

Story of the Fire.

At 4:30 P.M. the fire alarm operator received a call from Engine 1, located at the corner of Bank and Sparyard Streets, reporting a serious fire in the Humphrey-Cornell building on Sparyard Street. The operator immediately dispatched Engines 1 and 2, Hose 5, and Truck 1. Chief Thomas H. Shipman, who was returning to headquarters from an emergency call, saw the great column of smoke and immediately responded and took charge.

By the time the fire department arrived the blaze had gained great headway. The first company to arrive laid two lines from a hydrant on Sparyard Street. Within five minutes from the time of the alarm the gale had driven the blaze through the entire Humphrey-Cornell building. Due to the spread of the fire and the rising water, the apparatus was soon removed from Sparyard Street and one hose line had to be abandoned while the other was removed.

At 4:36 P.M. headquarters also received a call for a roof fire in the Palmer Brothers mill a few blocks from the Humphrey-Cornell blaze. Engines 3 and 7, and Truck 2 were ordered to respond, but Engine 7 was unable to get out of quarters due to a fallen tree and did not get to the fire. At the same time the operator requested help from the United States Coast Guard Academy at New London. Fortunately there was no fire at the Palmer Brothers mill, but the roof had been blown off. As the Humphrey-Cornell blaze was spreading, Chief

The one and four-story buildings at the right were protected with automatic sprinklers. Although these structures were seriously exposed and considerably damaged, the sprinklers were credited with checking the fire at this point.

Shipman immediately ordered Engine 3 and Truck 2 to respond to the fire and asked the operator to obtain all available help. All paid firemen on both platoons were on duty at the fire with the exception of the driver of Engine 7, making a total of 23 paid men on duty. There was no means of notifying the volunteer members and it is not known just how many responded.

Within a very few minutes after the start of the fire it had spread to the near-by Sisk building on Sparyard Street. It quickly crossed the street and ignited the coal pockets of the Chappell Coal Company. From that point it quickly spread along both sides of Sparyard Street to Bank Street, where it ignited the Putnam Furniture Co. building and the quarters of Engine 1. Sparks jumped across Bank Street and ignited the roof of Thompson's garage, which was destroyed. The fire came out of Sparyard Street so fast that the fire department did not have time to remove their hose lines, and lost considerable hose. The flames spread northwest along Bank Street, destroying the New London Grain Company buildings. Two brick sprinklered buildings finally checked the spread of the fire in this direction, although they suffered considerable damage. Firemen entered these buildings in advance of the fire and knocked out numerous sprinkler heads, which effectively held the fire. However, several brick warehouses and a grain elevator in the rear of these buildings were destroyed or badly damaged.

The Thompson garage on the north side of Bank Street was ignited by flying brands and radiated heat. Note how the unprotected steel beams sagged, pulling in the walls at both sides of the building.

While the fire was spreading along Sparyard Street it also quickly involved a group of large brick-joisted lumber warehouses and woodworking buildings of the Nassetta Brothers near the railroad right-of-way. From that point flames attacked the rear of the large four-story fire-resistive and semi-fire-resistive warehouse of the Plaut-Cadden Furniture Company on Bank Street. This structure was practically destroyed. Next attacked was the three-story sprinklered building of the Eaton and Wilson Company, hardware dealers. This property was so severely exposed that the inside sprinklers were unable to keep the fire out, and a total loss resulted. Adjoining buildings to the northeast were also destroyed. In the rear the fire was stopped at the coal pockets of the Central Coal Company, where an open space gave the fire department an opportunity to make an effective stand.

All during the fire the firemen worked under most difficult conditions. The gale was so strong that it was almost impossible for the men to stand on their feet and handle the hose lines. Even with high pressure supplied by pumpers, streams would not carry more than a dozen feet before being torn into spray by the force of the wind. Although forced back several times, the fire department managed to keep ahead of the fire, wetting down buildings in its path until it was brought under control.

In addition to making fire fighting exceedingly difficult, the gale showered the area north of Bank Street with burning brands, starting more than a dozen serious spot fires in a congested residential area along Tilley, Pearl, Starr,

Green and Union Streets. These fires caused the fire department much concern, and men and apparatus were rapidly shifted from one location to another as the fires were reported. Among the structures seriously damaged by these "spot fires" were the Masonic Lodge on Starr Street, where the roof was blown off, allowing the fire to enter, and the Union Lodge Hall on Union Street, which suffered about a 50 per cent loss. The city relief station at the corner of Green and Pearl Streets and an adjoining dwelling on Green Street were also badly damaged. A dwelling on Tilley Street in the rear of the Thompson garage was destroyed, and several dwellings on Starr Street, across from the Masonic Temple, were badly damaged. One slight fire on Main Street, half a mile from the original fire, was extinguished by a bucket brigade under the direction of the city electrician, who responded because no fire apparatus was available.

Although regular lines of communication were out of service, the fire alarm operator made every effort to obtain outside help. Runners were sent on foot through the storm to call the fire departments of neighboring towns. Most communities could not be reached by telpehone or telegraph. Calls for help which went to New Haven and Hartford by telephone could not be answered due to the condition of the roads and because every city fire department was fully occupied by emergency work.

A few near-by volunteer fire departments did fight their way through the storm and gave valuable assistance. The first to arrive were pumpers from the Jordan and Oswegatchie companies from the town of Waterford. They arrived at 5:30 P.M. About an hour later a pumper arrived from Groton, Conn., and was put to work at the fire.

Second Conflagration Threatened.

Just as the main conflagration was beginning to be brought under control at 11:15 P.M., a call was received for a fire in a three-story apartment building on Pequot Avenue in the Green Harbor Beach section of New London, about a mile distant. The Coast Guard pumper had by that time been sent to headquarters to cover the city and was dispatched, along with a hose company from the main fire. The fire started when a tenant dropped an oil lamp in a store on the ground floor. Fire apparatus had great difficulty in reaching the scene due to débris in the streets, and the firemen were forced to carry their hose and equipment by hand the last part of the distance. The Coast Guard Academy pumper was driven to the river from Green Harbor Beach and supplied three lines of hose. One of these was used on the actual fire and two were directed on exposed property. As the fire was seen to be spreading, a call was sent for more help and Engine 1 was sent from the Bank Street fire to assist. The fire spread to an adjoining dwelling, which was destroyed, and a near-by shed was damaged. The reason for the great headway of this fire was because it was necessary to drive to fire headquarters to sound an alarm.

Rear of the Plaut-Cadden furniture warehouse. It was from the exposed rear that the hurricane driven flames communicated to the warehouse from nearby lumber and coal storage buildings.

Shortly after midnight apparatus from the Goshen Fire Department reported at fire headquarters after chopping through thirty-two trees and taking over ten hours to go three and one-half miles. Their flood lighting equipment was sent to the conflagration and proved to be of great value, as the New London department lacked such equipment and all power in the city was shut off. The Goshen pumper remained at headquarters to protect the city.

Cause and Loss.

The cause of the fire is unknown. There appears to be no foundation of fact in rumors attributing the start of the fire to an explosion aboard a ship at the waterfront. As all power was off shortly after 2 P.M. the fire could not have been of electrical origin, as was also commonly reported. All that is known is that fire followed the collapse of a portion of the Humphrey-Cornell building caused by the hurricane.

The loss has not been finally determined. The fire department's preliminary estimate indicates a loss of approximately $1,000,000.

Conclusions.

The New London Fire Department deserves much credit for stopping this fire under such extremely difficult circumstances. Most observers cannot understand how it was possible to hold the fire in check with the facilities at hand during a hurricane. Had the main fire crossed Bank Street it seems probable that a large part of the city might have been lost. The same thing would have been true had any of the exposure fires gotten out of hand.

This conflagration, occurring at a time when a great hurricane disaster made outside help unobtainable, proves that while mutual aid systems are highly desirable, they cannot be relied upon to furnish primary fire defense. Each city should have sufficient fire equipment and manpower to meet the threat of local conflagration hazards unaided. The same conditions might prevail during a winter blizzard. In the case of New London there was a particular need for more paid officers. At the time of the fire Deputy Chief Calvin N. Edmunds was at home on sick leave. At great personal sacrifice he faced the hurricane and worked at the fire until he collapsed and was removed to the hospital. From that time on, Chief Shipman had to cover the entire conflagration area and supervise the fighting of all the exposure fires alone. The conflagration lends weight to the long standing recommendations of fire protection experts that paid officers and more paid firemen be provided along with the paid drivers now available for each company to form a nucleus for a paid fire department in the city.

It may be noticed from the map that several wooden buildings which were apparently severely exposed and which were located at points inaccessible to the fire fighters, escaped the conflagration, while near-by brick structures were destroyed. The reason for this would presumably be that the high winds tended to dissipate the heat and that the rain which accompanied the storm gave these buildings some protection. Also heavy showers which preceded the hurricane had thoroughly wet down buildings in the path of the flying brands.

Motorship Lafayette Fire, Le Havre, France

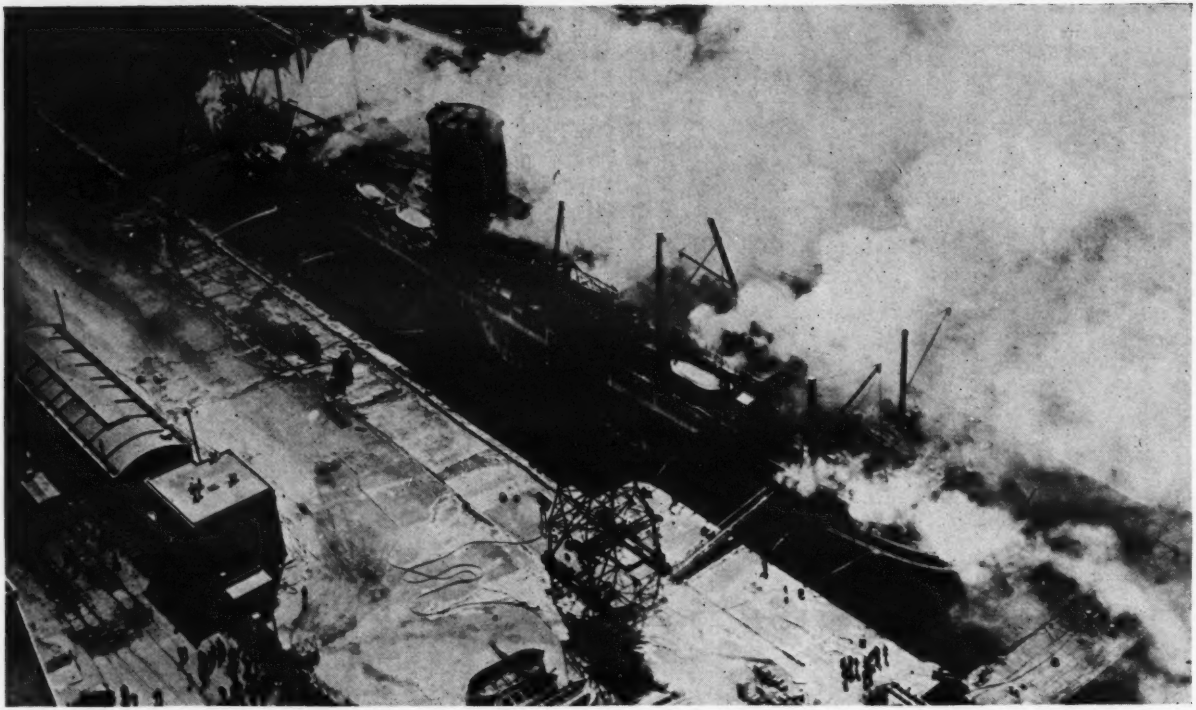
The luxury French liner *Lafayette* of the Compagnie Générale Transatlantique was completely destroyed by fire on May 4, 1938, while in dry dock at Le Havre, France. The fire started in the engine room and spread with alarming rapidity to all parts of the ship, resulting in a property loss of about $3,500,000, and the loss of one life.

The *Lafayette* had been in service between Le Havre and New York, and at the time of the fire it was in dry dock for examination and repair. The ship was one of the most elegantly built French liners, and had been in service eight years. It had a gross tonnage of 25,178, and was 615 feet long and 84 feet wide. It was powered by four diesel engines and had accommodations for 1078 passengers and a crew of 485. Fire protection equipment consisted of standpipe and hose, steam and foam extinguishing systems, and first-aid fire appliances.

About 9:15 P.M. on May 4, while a member of the skeleton crew aboard the ship was lighting an oil burner under an auxiliary boiler in the engine room, a small quantity of fuel oil which had been spilled on the floor was ignited. The fire spread rapidly, soon igniting oil that had accumulated in the space under the engine room flooring. The exact circumstances are not altogether clear and the sequence of events is somewhat a matter of conjecture, but it appears that the combination of a number of factors was responsible for the initial spread of the fire. There was only a skeleton crew in the engine room, and the usual equipment and organization for fire fighting were not available. The engineer on watch turned in a fire alarm and members of the crew used hand extinguishers, apparently with little effect, perhaps due to the fact that the burning oil under the engine room flooring could not be readily reached. Members of the ship fire brigade on board promptly responded and attempted to put two foam hose lines into operation. However, the pipe lines had been disconnected during overhauling operations and no foam could be applied. Similarly, steam was not available for fighting the oil fire, and the water fire lines were also out of commission. The heat and dense smoke interfered with fighting the fire at close range with hand extinguishers. All accounts agree that if the vessel had been in commission, with the regular extinguishing equipment available, the fire could have been readily extinguished before it reached serious proportions.

The fire continued to spread rapidly, presumably fed by oil escaping from tanks or piping in the engine room. The municipal fire department

Note: This account has been prepared from information assembled from foreign marine and underwriting sources by Samuel D. McComb, President N.F.P.A.



Acme.

Fire raged almost unchecked throughout the length and breadth of this luxury motorship "Lafayette" while in dry dock at Le Havre, France, on May 4, 1938. The ship's fire protection facilities could not be used. The loss was $3,500,000 and one life.

responded promptly, but their work was of limited value because of the practical impossibility of reaching the seat of the fire. Some twenty hose streams were directed at the vessel from the side of the dock, but the water could not reach the seat of the fire. Some members of the municipal fire department also went on board and helped the crew in the inside fire fighting.

Heavy smoke permeated the vessel and poured through the funnel and ventilators. The lights on board soon failed when the fire reached the main electric connection supplying current from the shore, the ship's electric generating equipment being out of commission. The auxiliary automatic lighting system also did not function, as this had been dismantled for the annual overhauling. Dense smoke, darkness and the difficulty of reaching the vessel from the dock side all contributed to the difficulty of any effective fire fighting.

There is no evidence to indicate just how the fire spread from the engine room to other parts of the vessel—whether the fire bulkheads around the engine room were incomplete, or whether doors had been left open. Once the fire was beyond the engine room, flames spread rapidly through combustible interior trim, light bulkhead construction and furnishings in the passenger spaces which had no effective fire cut-offs. Open stairways between decks, and portholes left open for ventilation produced draft conditions conducive to the rapid spread of fire. About two hours after the start of the fire the entire ship was involved and huge flames came through the decks amidships. The men on board who were fighting the fire were cut off from the single gangway which had been placed between the dock side and the after end of the vessel. One man managed to throw down rope ladders from an upper deck over the portholes behind which his comrades were trapped. Some twenty men climbed down these ladders only to find themselves 40 feet above the concrete floor of the dock. Havre firemen went to the bottom of the dry dock and set up ladders and rescued the men on the vessel. About midnight a second gangway was placed forward, and another group of about thirty men who had been driven to the hold of the vessel were saved.

At about this time compressed air tanks in the engine room began to explode, with a series of explosions lasting until about 4 A.M. The danger was such that everyone was ordered away from the dry dock, and the firemen removed their equipment to a safe distance. No further fire fighting was possible and the ship was left to burn. By daybreak it was practically a complete wreck and still burning. The superstructure was a mass of twisted iron and steel, and the shell was buckled in various places.

It was hoped that there would be no loss of life, but at the end of a few days, when the temperature of the liner had cooled down and a commission of inquiry went on board, the remains of one victim were discovered. The ship was a total wreck, with a loss estimated at $3,500,000. It was sold in June and towed to Rotterdam, Holland, for breaking up.

The Canadian Pacific Railway Company's Pier D being destroyed by fire on July 27, 1938, with a loss of $780,000. The superstructure was sprinklered, but without fire walls. The creosoted wooden substructure was not provided with fire walls or sprinklers.

Canadian Pacific Pier Fire, Vancouver.

By F. F. Dowling,
Fire Branch of the British Columbia Insurance Underwriters' Association (Member N.F.P.A.).

On July 27, 1938, about 1:30 P.M., a fire started at the water end of the Canadian Pacific Railway Company's Pier D, located on Burrard Inlet, Vancouver, B. C., and within a short time destroyed the entire pier and also a freight shed and part of an elevated roadway structure at the land end. The one boat at this pier and another at the adjoining pier were able to pull away before being damaged. The loss was approximately $780,000. Several firemen were injured. This was the largest pier fire in Vancouver since fire destroyed the Canadian National Steamship Co. pier on Burrard Inlet in 1930 (see October, 1930, QUARTERLY, page 211), with a loss of over one million dollars.

Lack of sprinklers under the deck and combustible pier construction permitted the fire to spread rapidly. As was the case eight years ago, the city had no fireboat in the Inlet to protect the valuable wharf property.

Construction and Fire Protection.

The pier was of frame construction on open creosoted piling above tidewater and was about 25 years old. It was owned and operated by the Canadian Pacific Railway for passenger and freight coastal service. The superstructure

The stage of the fire at 1:52 P.M., or about six minutes after the fire department received the alarm. The fire started under the pier deck at the far end and spread rapidly under the pier where it was inaccessible to fire department hose streams and water from sprinklers in the superstructure.

This picture was taken three minutes after the first one, or at 1:55 P.M., as determined by the clock on the face of the pier. The masts and funnel of the company's boat, "Princess Charlotte," can be seen on the other side of the pier. She got up steam and pulled away just in time. The boat on the left, "Princess Adelaide," pulled away before the next picture was taken.

was approximately 135 feet wide and 900 feet long, with composition roof. It was two stories high for a length of about 250 feet from the land end—the second floor being occupied as waiting rooms and offices. The walls of the first floor were corrugated metal on heavy wood frame. Double 1-inch draft curtains about three feet in depth were erected below the roof approximately 100 feet apart.

The deck consisted of 2-inch hardwood laid diagonally on 4-inch laminated construction on 7 by 12-inch joists. Under this were 10 by 16-inch caps on piling spaced on 8-foot centers. All joists, caps, bracing and piling below the deck were of creosoted timbers. A depression in the deck contained two railway sidings which ran down the center nearly the full length of the pier. The side walls of this depression were four inches thick. An asphalt driving surface about 4 inches thick and 30 feet wide was laid on top of the flooring on each side of the depressed track. There was a platform ranging from 12 to 16 feet wide on the outside of the superstructure on all three sides. Double 3-inch creosoted transverse fire stops were erected approximately 200 feet apart below the floor to mean low water, and a similar longitudinal fire stop was along one side of the depressed track. Trap doors 2½ feet square were installed in the floor of the pier, one in each fire stop area, with a platform underneath the floor at each trap door for fire fighting purposes. There were no fire walls.

On one side of the pier, over the railroad tracks along the shore, was an elevated street that connected with the second floor. On the other side of the

By 2:12 P.M., when this picture was taken, over half of the pier was involved.

pier, 25 feet away, was a frame metal-clad freight shed about 300 feet long paralleling the tracks, and not equipped with automatic sprinklers. The space below the floors of pier and shed communicated without cut-offs.

The pier was protected with about 2784 sprinkler heads on six dry-pipe systems, but no sprinklers were installed under the deck. The pier was equipped with inside standpipes, hose and first aid fire extinguishers. There was a combination night watch and fire alarm box system, and supervisory service on the sprinkler system, both of which systems were supervised by the company's police department one block away. This equipment was also equipped with a relay to automatically transmit a fire alarm direct to the city fire department. Outside protection was fair to good from five hydrants located within 500 feet along the railway tracks on the land end of the pier and fed by a 6-inch main. There was no hydrant protection at the water end of the pier. The sprinkler equipment was supplied by two 8-inch connections to a 10-inch dead end main, giving 105 pounds pressure at the highest line of heads. Each 8-inch connection was equipped with a 4-way fire department connection.

Story of the Fire.

Shortly after 1:30 P.M. smoke was observed coming out from under the decking at one corner of the water end of the pier, and the first flames emerged from about four feet below the decking. A light wind was blowing the smoke toward the other corner of the pier and away from the shore. A longshoreman, who was loading freight on the company's boat, the *Princess Charlotte*, tied up on one side of the pier about 300 feet from where the fire started, saw the smoke about 1:43 P.M. and notified a company police constable. They investigated the fire and turned in an alarm from a private fire alarm box at the water

Soon the entire pier was engulfed and part of the overhead approach to the second floor of the pier, seen in the foreground, was damaged.

end of the pier. The longshoreman then got out hose lines at several standpipes and turned them over to employees to operate.

Fire Fighting Operations.

The fire department received the alarm at 1:46 P.M. and responded immediately with six pieces of apparatus and 32 men. The longshoreman helped the firemen raise one of the floor hatches near the end of the pier to permit the department to operate a hose line below the floor, but the flames burst through with such force that they had to retreat before they could replace the hatch. Three additional alarms brought the total equipment at the fire to 13 pieces manned by over 60 firemen. The first firemen responding laid six hose lines into the pier on the first floor from hydrants. Later the pumpers were used, one pumper being connected to one of the fire department connections feeding sprinklers. This proved of no value, owing to the extent of the fire by this time. It appears that the first two pumpers responding should have immediately siamesed in on these important connections. Apparently, because of low tide, pumpers could not obtain suction from salt water in the early stages of the fire. Eighteen hose lines had been laid, but the streams were not strong enough or sufficient in number at first to combat a fire of this size. Later, when five pumpers took suction from hydrants and three from salt water, the fire was practically out of control.

There is no fireboat on Burrard Inlet. Four firemen tried to direct a stream on the fire from a raft, but were forced away. The city's fireboat on False Creek was called at 2:14 P.M. and reached the pier about an hour later, at which time it was of little assistance.

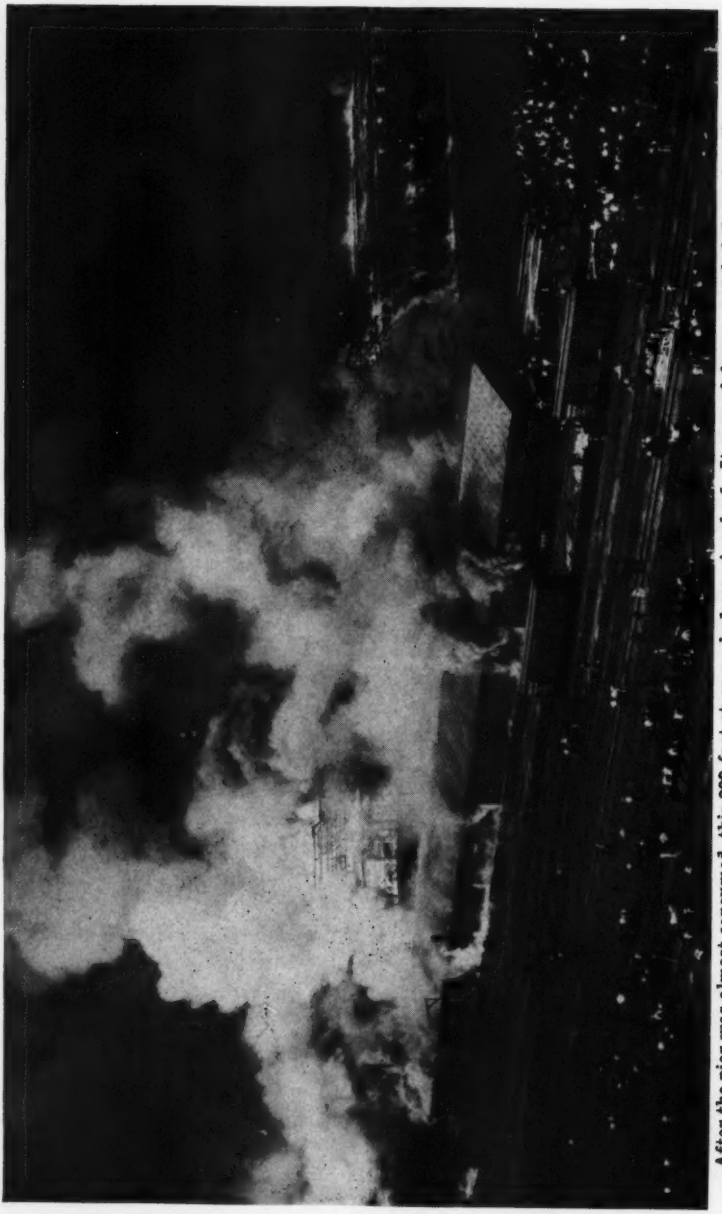
The fire at its height about one hour after it started. The overhead approach at the extreme left is involved, and the storage shed in the forground is about to catch fire.

The fire spread rapidly, at first under the deck and finally above. The sprinkler systems at the water end of the pier operated and worked satisfactorily for a short time, but the extent of the fire involved all sprinklers. This, together with the draw-off by the fire department hose streams, rendered the sprinklers ineffective. The transverse fire stops momentarily checked the progress of the fire under the deck, but it quickly burned around them and proceeded. The flames, smoke and gases swept over the outer apron or decking and enveloped the superstructure.

Fire finally spread to the company's unsprinklered freight shed, which was partly on the shore and partly over tidewater. It was completely destroyed. The overhead traffic approach to the pier was damaged for a distance of about 50 feet, the fireboat from False Creek being of some assistance in extinguishing the fire in this structure.

The entire pier was destroyed by the fire, including the piling above water. The loss to the pier and approaches was $720,000; to the stock on the pier $40,000, and to the storage shed $5,000. The city fire department lost a combination hose and chemical truck and about 3000 feet of hose with a loss of about $15,000. The total loss, therefore, was about $780,000.

The cause of the fire has not been definitely determined. It is thought that a lighted cigarette thrown from the deck could have been the cause, as it would have been possible for a cigarette to lodge on the capping after passing through a crack in the decking. Because of the age of the pier, there probably was a considerable accumulation of refuse and dust lodged on the capping.



After the pier was almost consumed, this 300-foot storage shed was involved. It was of frame metal-clad construction, unsprinklered, partly built on piling over tidewater.

The creosoted timber together with the lighted dust and refuse might be an explanation of the rapid spread of the fire. Although this deck was washed down each day at 11:00 A.M., there was no opportunity of washing the capping below.

Conclusions.

Loss of the pier may be attributed to the lack of automatic sprinklers under the deck, inadequate construction, and lack of fireboat protection on Burrard Inlet. Installation of such sprinklers was recommended to the Canadian Pacific Railway Company by the British Columbia Insurance Underwriters' Association at the time the sprinkler equipment was installed, but the company did not deem the extra expenditure advisable.

The facts that there were no fire walls in the superstructure or substructure, no fire-resistive extensions from the sides of the substructure, and other construction features as recommended by the N.F.P.A. standard on Piers and Wharves were important factors in the spread of the fire. While the transverse fire stops momentarily checked the progress of the fire, the fire quickly burned around them to attack the superstructure. The tide being low no doubt increased draft conditions under the deck.

Shortly after the arrival of the fire department the fire was beyond control. So many sprinkler heads had operated that the water supply was overtaxed, rendering the sprinklers unable to check the spread of the fire in the superstructure. Even if the first two pumpers responding had been connected to the fire department siamese connections to the sprinkler systems, it appears questionable whether the pier could have been saved, because the seriousness of the fire below the deck would probably have caused failure of the substructure and dropping of the superstructure into the water. The openings provided in the deck were not adequate for effective use of the fire department in reaching the fire below deck with streams of water. Had a fireboat been on hand during the first few minutes of the fire, the fire might have been checked.

As a result of this fire, and another one less than a week later involving a loss of about $200,000 to warehouse and manufacturing property, the City Council has appointed a special committee to make a complete survey of the fire protection facilities of the City of Vancouver, looking to the establishment of a modern fire school and to the provision of fireboats for safeguarding waterfront property.

Life.

Tank No. 180 killed three men as it fell.

Wellsville, N. Y., Refinery Fire.

A fire in the oil refinery of the Sinclair Refining Company at Wellsville, N. Y., starting Sunday, July 17, destroyed a portion of the refinery with a loss estimated at $1,000,000. During the fire a 2000-barrel tank containing a mixture of naphtha and oil exploded and fell in an open field nearly six hundred feet away, where three spectators were burned or crushed to death. About a hundred firemen and plant employees suffered minor burns, but there were no other fatalities. The fire was confined to an area of about 300 x 400 feet, only a small part of the refinery property, through unusually determined work on the part of the refinery fire brigade and volunteer firemen. The congestion of tanks and buildings, the explosions of tanks of highly flammable liquids, and the failure of the refinery water supply during the fire made fire fighting hazardous and difficult. The fire was completely extinguished only after fifty hours of fire fighting.

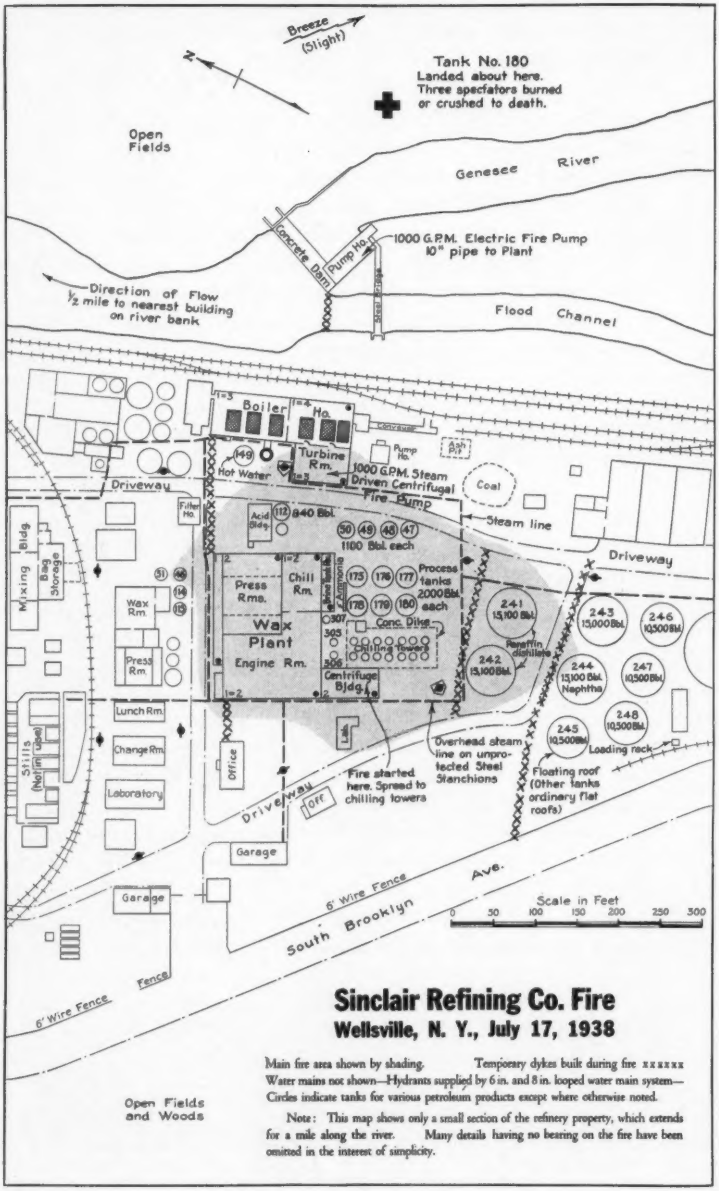
The Property Involved.

The Sinclair Refinery is a complete oil refinery producing all the usual products from a paraffin base crude oil. The area immediately involved in the fire was the wax plant, adjacent tanks, and part of the power plant.

The wax plant processes and equipment are complicated in detail but consist essentially in cooling by artificial refrigeration the residual oil left after gasoline and other products are removed from the crude. The cooling separates the paraffin wax from the lubricating oil of various grades. In addition to cooling, the process involves separation of oil and wax in filter presses, and in centrifugal machines known as centrifuges. There are several different interrelated processes involved, but as their technical detail has little bearing upon this fire they will not be described further here.

The centrifuge building where the fire started is generally considered to be one of the most hazardous portions of an oil refinery, and while the oil is handled only in closed equipment, as a matter of actual practice it is practically impossible to keep the centrifuge machines 100% tight due to occasional leakage, cleaning of machines, etc., and it may be expected that there will be more or less oil around the floor of such a building. The process includes the use of naphtha as a vehicle for separating the oil and wax, so that highly flammable vapors may be expected to result from any leakage. The building was of fire-resistive construction, as were other buildings in the fire area.

Note: This account is based upon a comprehensive report by Assistant Chief Inspector H. T. Remele of the Syracuse Division of the New York Fire Insurance Rating Organization (Member N.F.P.A.), and a 16-page illustrated report published by the Wellsville Volunteer Fire Department (Member N.F.P.A.).



Sinclair Refining Co. Fire
Wellsville, N. Y., July 17, 1938

Main fire area shown by shading. Temporary dykes built during fire xxxxxx Water mains not shown—Hydrants supplied by 6 in. and 8 in. looped water main system—Circles indicate tanks for various petroleum products except where otherwise noted.

Note: This map shows only a small section of the refinery property, which extends for a mile along the river. Many details having no bearing on the fire have been omitted in the interest of simplicity.

The centrifugal pumps in the room where the fire started were driven by electric motors. These motors were not of the modern, explosion-proof type, but were of the induction, squirrel cage, open type which, at the time of installation in 1929, were considered to be in accordance with good refinery practice. Other electrical equipment was of the vapor-proof type.

As shown by the plan, the centrifuge building was separated from the engine room of the wax plant by a blank wall, but this proved of no value in preventing the spread of fire to the engine room, where the ammonia refrigerating equipment was located, as this room had an unprotected pipe opening and a door in the outside wall through which the fire spread from cooling towers and tanks. Windows and a door on the east side of the centrifuge building were presumably open at the time.

Plant Fire Protection.

There was a well-organized plant fire brigade with a competent chief and divisional brigades made up of regular plant operators who were drilled regularly. There was a 6- and 8-inch looped water main system with standard hydrants well distributed. Twenty-two of these were equipped with hose houses with 100 feet of 2½-inch hose and other equipment. The water main system was supplied by an electric 1000 g.p.m. fire pump in a detached pump house on the Genesee River and also by a steam-driven centrifugal fire pump, also 1000 g.p.m., in the turbine room of the main power house. There was no supplementary water supply from the town mains, and no outside electric supply for the pump on the river bank, making the entire water system subject to failure in case of trouble in the main power plant, which was exposed by various process tanks and buildings.

The plant fire department had five well-spaced fire stations, including among other equipment foam generators and three to six tons of foam powder in each station. A central fire station included a fire truck with additional hose and foam equipment.

Public Fire Protection.

The plant is just outside the Wellsville municipal line. Public hydrants on a 6-inch main in South Brooklyn Avenue adjoining the plant had a capacity of 750 gallons per minute. The Wellsville Fire Department consisted of two pumpers, one a combination truck and one a ladder truck, one or both of which always respond to all plant alarms and stand by at the gates, as it is a mutual understanding that any equipment entering the property shall be under the direct supervision of plant officials. The entire Wellsville department responded to this fire and also over 200 volunteers from more than 20 fire departments in communities within a radius of fifty miles, most of them bringing apparatus.

Start of the Fire.

On Sunday afternoon, July 17, the refinery was operating as usual, the plant being on a seven-day a week schedule. No maintenance crews were working. The only employees in the area where the fire started were the usual operating men. This personnel was made up of competent skilled men who fully appreciate the fire hazard. Under the circumstances it seems highly unlikely that fire could have been caused by smoking or any similar careless act on the part of the regular employees.

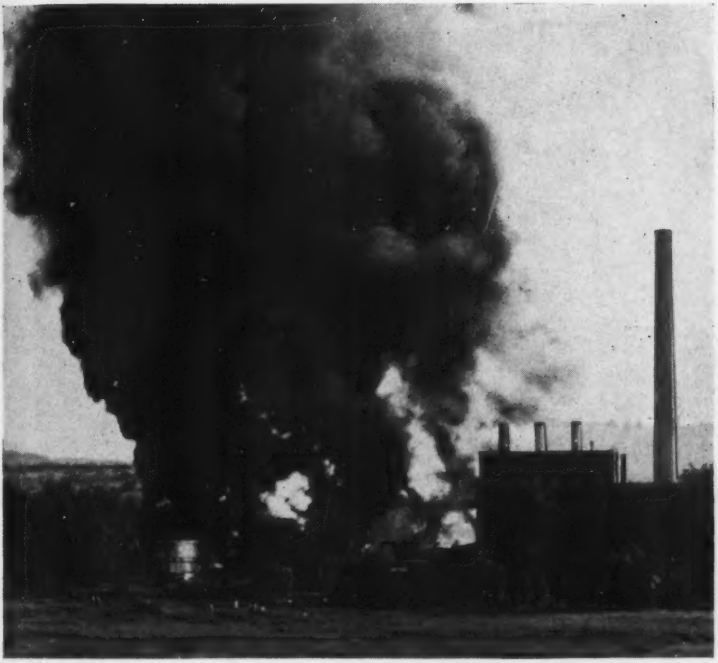
At the moment there was no one on the first floor of the centrifuge building, which contained tanks, automatic pumps which were in operation, and other equipment. About five minutes earlier the operator had been in the room and found everything normal. There was no unusual odor to indicate gas accumulation, and regular test of the room vapor had been made by the plant laboratory a short time previously. Sometime between 4:40 and 4:45 P.M. an employee on the second floor of this building saw smoke coming up through pipe openings in the floor. He immediately ran to an outside stairway and called the pump man who was operating a tank valve several hundred feet away. In accordance with previous instructions he rushed to a steam valve outside, designed to flood the building with live steam in case of fire. The steam apparently had little or no effect and the fire continued to spread.

As the centrifuge building and its equipment were completely wrecked by the fire, it was impossible after the fire to secure any positive indication of the cause. In the absence of any other probable cause, some failure of a non-explosion proof motor or other electrical equipment, or failure of a stuffing box or pipe joint releasing oil into a motor, seems to be the most plausible explanation.

Fire Fighting.

The fire was quickly seen by several other employees, who ran to the nearest fire station and proceeded to man the equipment. The boiler room engineer was notified by telephone and an alarm was sounded by the plant whistle at 4:48 P.M. A moment later the fire pump was started. Other companies of the plant fire brigade then responded, and the Wellsville fire department was called in a few minutes.

A foam stream was quickly brought into play and directed on the fire at the south end of the centrifuge building, but in the very brief interval before this stream was brought into play the fire had spread to the eight-inch thick cork insulation on the chilling towers in the adjoining yard. This insulation burned intensely. The burning cork was showered on the firemen, making it necessary for them to withdraw and change position. Within a few minutes after the first alarm several foam streams were brought into play around the fire in the centrifuge building and adjoining chilling towers. The number of



Wellsville Volunteer Fire Department.

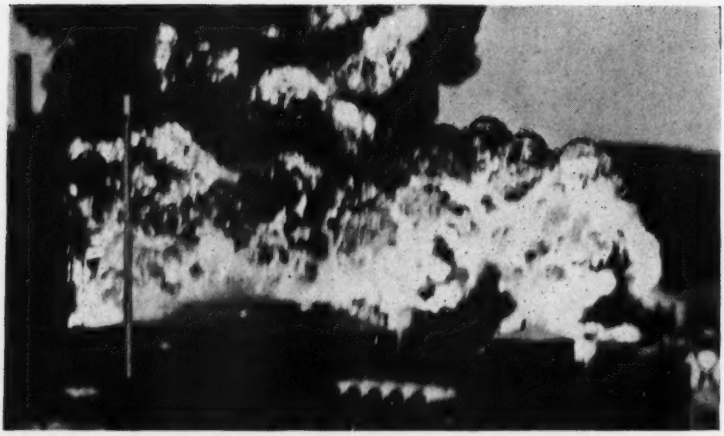
The spectators on the river bank seemed at a safe distance, but were directly in the path of the exploding tank. (See photograph on page 142.)

foam streams varied with the changing of lines and positions as the fire spread. About eight streams were in use at times.

Spread of the Fire.

Due to the intense heat from the fire in the centrifuge building and the burning insulation around the chilling towers and adjoining process tanks, pipe lines ruptured and released flaming oil through interconnecting pipe trenches or on the ground. These trenches had steel plate covers and were not provided with any fire cut-offs. The fire soon spread to other process tanks and into the engine room of the wax plant building. Several times the plant fire brigade carried lines to this room and smothered each surge of fire in the room until explosions in the process tanks in the yard made further operations inside this building impossible.

The intensity of the fire continued to increase, but its spread was checked. For more than an hour it was confined to the centrifuge building, chilling towers and process tanks. During this interval public volunteer fire depart-



Wellsville Volunteer Fire Department.

The explosion of tank No. 180 enveloped the fire area in a blast of flame. This picture was taken looking southeast from the open country across South Brooklyn Avenue.

ments with pumping equipment from surrounding villages, in addition to three Wellsville companies already in service, arrived and offered their services. Eight pumpers taking suction from the river were used at various times with only water streams for cooling and wetting down. Nine other departments stood by for several hours, but were not used. Over 160 volunteer firemen assisted the regular plant brigade in constructing temporary sand bag and earth dikes to prevent the possibility of flooding oil from spreading the fire, also in directing water and foam streams on exposed tanks and buildings, particularly the turbine house and the main section of the wax plant.

The First Explosion.

At 6:00 P.M. tank No. 180 exploded. This 2000 bbl. tank, about 25 ft. in diameter and 25 ft. high, was about two-thirds full of a mixture of naphtha and lubricating oil stock. When tanks of this type with inadequate emergency relief vents fail from excessive internal pressure the top usually lifts from the shell, but in this case, due to reinforcing of the top by steel beams used to support machinery operating a stirring mechanism, the top had greater strength than the bottom. The rivets in the bottom angle sheared and the side wall shell and top ripped loose from the bottom with terrific force and skyrocketed several hundred feet into the air over the river pump house and landed on the opposite bank of the river nearly 600 ft. away. In the open fields across the river were a considerable number of spectators, at a distance that would have seemed fully safe. As the tank hurtled through the air, dropping flaming oil,

the spectators rushed away, but three were caught as the tank fell and were burned or crushed to death. There was a flash as the tank landed, but no sustained fire here. Several others suffered burns. On the bank of the river, directly under the path of the flying tank, were a dozen firemen operating pumpers drafting from the river. Some ran and others jumped into the river to escape the burning oil and falling pieces of metal. Several of these men were burned, but all survived.

The terrific heat wave accompanying the explosion broke and melted large-area plain glass windows in the west wall of the turbine room. On the ground floor a surge of burning oil damaged transformers and other electrical equipment, but the steam fire pump in another end of the room was not harmed. On the second floor switchboard insulation was ignited and destroyed and generator windings were damaged. This damage is believed to have been caused by the intense heat wave, as apparently no oil burned in this room. The turbine room operator was forced to leave a moment after the explosion and pressed the emergency button cutting off the entire plant electrical supply, which stopped the electric fire pump, as there was no secondary electric supply. The boiler room was not damaged, as steel doors on communicating openings were closed by the operators, preventing a spread of fire to that section.

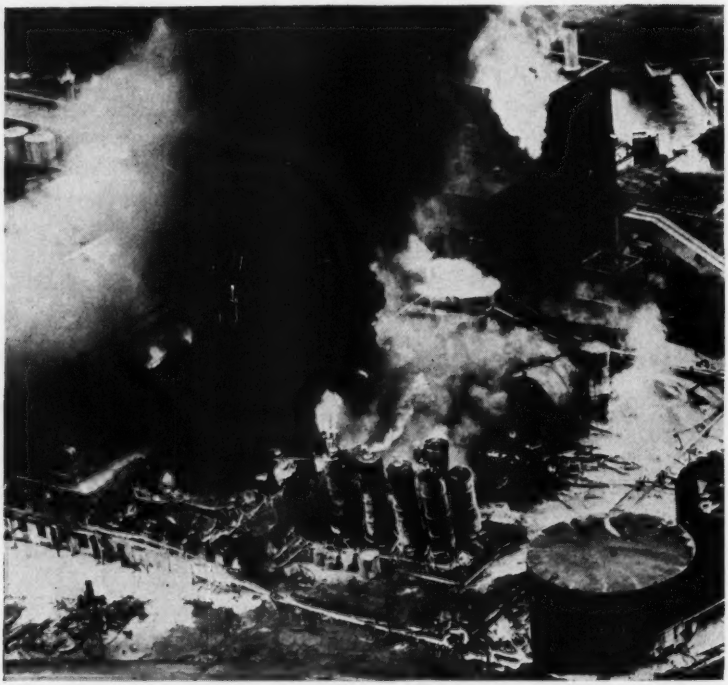
Water Supply Failure.

Water pressure in the fire lines could have been maintained from the steam pump, but at about 6:05 P.M. the unprotected steel stanchions supporting the main steam line outside along the west wall of the power house and along the centrifuge building buckled, causing the steam line to part. Anticipating such a failure, valves controlling the outside steam lines had been closed, but the heat also caused failure of the steam lines inside the turbine building. There was then no way to shut off the broken steam mains while fire was burning in the ground floor of the turbine building, and the loss of steam completely crippled the power plant, stopping the steam fire pump.

As soon as the blast of flame subsided and the fire in the turbine room died down, emergency repairs were started to blank off the broken steam main, despite the hazard of explosions of other near-by tanks in the fire area. During the course of the fire several other tanks exploded, but there is no record of the circumstances of these subsequent explosions. The photograph on page 151 indicates that tanks Nos. 177, 176, 47, 48 and 49 exploded, but none was carried to any great distance.

The steam service was restored at 6:45 P.M., forty minutes after the break, and at 7:12 P.M. the steam fire pump was again started, two employees operating the pump while fire was still around the building.

While the plant water system was out of service, fire department pumpers continued to pump from the river and one Wellsville pumper, stationed on



Acme.

The fire area looking toward the river. Note ruins of centrifuge building in the left foreground, chilling towers in the center foreground, and broken steam line at the corner of the turbine room in the center background. Foam (light color) covers the ground over a large area around the fire.

South Brooklyn Avenue, taking suction from a public hydrant, pumped two hose lines into a yard main hydrant at the north end of plant and maintained a pressure of 30 to 35 pounds, sufficient to supply one foam stream, after only about ten minutes delay. For the next hour the fire was held in the same area, but the oil was then burning intensely in the engine and chill rooms of main wax building. When steam pressure was re-established and the steam fire pump connected, foam lines were again applied to the fire area at close range and until about 9:00 P.M. no further spread occurred. Tanks Nos. 241 and 242, nearly full of paraffin distillate, were saved by cooling with water spray. Naphtha storage tank No. 244 had been cooled by water, but finally exploded. A part of the cone roof tore loose from the shell for a distance of 10 or 15 ft. It lifted in the manner of a hinge, then settled back and snuffed the tank fire out.

Shortly after 9:00 P.M. the fire spread to the wax plant press room, due to

Wellsville Volunteer Fire Department.

The ruins of process tanks and chilling towers, looking west from the power house.

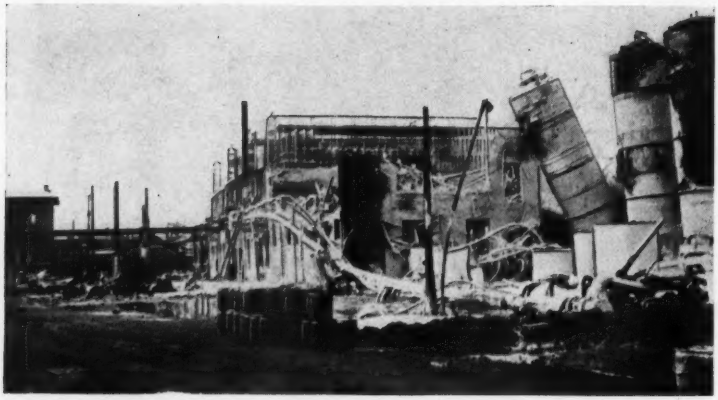
the burning out of refrigerator doors from the chill room. Foam streams played through outside door openings were an important factor in limiting the amount of damage in this part of the plant.

Final Extinguishment.

Subsequently, the fire was held in check and gradually controlled except in the inaccessible process tanks in the yard and cork insulation in press rooms that burned out during Monday and Tuesday. At about 4:00 A.M. Monday, tank No. 48 exploded and landed on top of tank No. 49, but this was the last major explosion. Late Tuesday only the contents of tank No. 178 were burning. This proved a stubborn blaze coming from a small opening at the top angle. Carbon dioxide gas equipment had been rushed from Buffalo and was being assembled when a steam line was applied. This caused a flare-up which opened a large hole and admitted sufficient foam to smother the last semblance of fire at 6:30 P.M. on Tuesday.

The Loss.

The character of the damage is shown by the accompanying photographs. The centrifuge building and contents and process tanks adjoining were a complete loss. Also the machinery and equipment of the wax plant were practically a total loss. The building damage was severe, principally in the south wall, which bulged and cracked in several places due to failure of two unprotected steel columns. In the turbine house the contents were considerably damaged, and the second floor badly buckled due to warping of two steel



Wellsville Volunteer Fire Department.

Another view of the ruins of the Wax Plant. Note cans of foam powder in the foreground. Two hundred and twenty-five thousand pounds of foam powder was used in fighting this fire.

columns, each with an exposed unprotected flange. A few minor buildings and small tanks within the fire area were totally destroyed or badly damaged.

A feature of indirect loss was the interruption of electric power supply to Wellsville and six other communities. The main power lines crossed the refinery property, and though there was no connection between these lines and the plant system, the electric service failed at 5:24 P.M. Sunday. The Wellsville municipal power plant, closed for summer repairs, was rushed into partial operation at 6:25 P.M. Complete service was not restored until 6:37 P.M. Tuesday, when linesmen crossed the refinery with new circuits.

Foam Used in Fire Fighting.

While the fire spread was checked largely through the human element of expert fire fighting, the value of foam protection in adequate quantities was conclusively demonstrated. Approximately 225,000 pounds of foam powder was used in fighting this fire. The American LaFrance plant at Elmira, N. Y., 70 miles away, was called by telephone shortly after the fire started and a convoy of trucks carrying foam powder with police escort was rushed to the refinery and arrived within a few hours. Small quantities were also obtained from the Wellsville fire department and private sources near by. An ample quantity was on hand at all times.

It is the consensus of opinion of those investigating that the sheer determination of the men fighting this fire under the cool-headed and competent supervision of the superintendent, his assistant and the engineer in the face of momentary catastrophe were responsible to a large degree in confining this fire and preventing the spread to adjoining areas.

The only personal injuries in the plant as a result of the fire were minor burns.

Editorial Comment.

The several factors which were responsible for the start, spread and difficulty of control of this fire may be found duplicated in many other refineries, and the management cannot be well criticized for conditions which were considered to be in accordance with good practice in the industry at the time the plant was erected. The tank explosions point forcibly to the importance of the maintenance of some effective form of emergency relief to vent excessive pressure in case a tank is surrounded by fire as specified in detail in the N.F.P.A. Suggested Ordinance on Flammable Liquids. The provision of adequate emergency venting facilities is not now common practice in oil refining properties.

The likelihood of spread of fire from one unit to another in a property of this kind would obviously be decreased by a substantial degree of separation between the various buildings or units. The American Petroleum Institute recommendations for fire protection in oil refineries, developed by a committee under the chairmanship of the late Mr. C. H. Haupt, former vice-president of the N.F.P.A., and published in 1933, call for substantial distances between various units. For example, this report calls for a distance of from 100 to 200 feet between a power plant and any process unit, whereas in this plant, built in 1929 and earlier, this distance was only about 50 feet due to lack of available space. The A.P.I. report covers most of the important factors in this fire. It recommends, for example, that oil lines should be buried rather than placed in open trenches, and specifies that if pipe trenches are used fire stops should be provided at intervals by filling the trench for a distance of 10 or 15 feet.

The arrangement of a plant fire protection system in such a way that the water supply is subject to complete interruption due to a fire or other trouble at some one point is an obvious violation of good practice in fire protection engineering. The failure of the steam supply, which was a vital factor in the interruption of the plant water system, is another point covered by the A.P.I. report, which states that "Where the steam supply is important for fire fighting . . . the location of the main steam supply line should be carefully considered with respect to adjacent hazards. . . . In some cases the fireproofing of overhead line supports may be found advisable."

The failure of steam to control the fire in the centrifuge building at the start might have been expected in view of the well-known fact that steam is not effective as a fire extinguishing agent for large open rooms at ordinary temperatures, where the steam condenses on contact with relatively cool surfaces. Tests have shown that steam is effective only in normally heated enclosures, such as ovens, or where its application is continued for a long enough period, sometimes a matter of hours, to heat the entire contents of the room to the point where condensation will not occur.

The origin is not conclusively associated with the electrical equipment, but this fire would strongly point to the desirability of the more general use of explosion-proof electrical equipment in such hazardous locations.

The large scale use of foam on this fire was of primary importance. This was possible only by reason of the availability of a large supply of foam powder in the plant of a manufacturer within trucking distance. This points to the importance of having very large supplies of foam producing materials on hand or available within a short distance if foam is to be effective for major fire fighting operations.

The fact that there were not more casualties in this fire was apparently due to the unusually intelligent direction of the fire fighting operations by the superintendent, Mr. W. B. Chenault, and his assistants, who fully appreciated the character of the hazard. This fire demonstrates the wisdom of having fire fighting operations in a hazardous plant directed by men familiar with the special hazards peculiar to such a plant.

Transformer Vault Explosions.

By L. W. McCullough (Member N.F.P.A.),
Consolidated Edison Company of New York, Inc.

The survey and report on which this article is based was undertaken for the benefit of a special Technical Subcommittee on Transformer Vaults of the N.F.P.A. Electrical Committee. The report presents information on the frequency of occurrence of vault fires and explosions* and on the causes and results of such occurrences. It covers the experience of operating companies in Boston, New York City, Philadelphia, Washington, Baltimore, Pittsburgh, St. Louis, Cincinnati, Detroit, Rochester, Chicago, Buffalo, Newark, and a number of other cities. It includes sidewalk vaults and indoor vaults on consumers' premises, and covers a period within the memory of the present operating staff or to the extent that records are available.

The comparative freedom from vault troubles, in view of the transformer-years operation covered, is evidenced by the fact that 24 out of 36 companies included in the survey had never experienced a fire or explosion in a vault on consumers' premises. Also it is of interest that in seven cities varying from 300,000 to 2,000,000 population the present operating staff has no knowledge of any injury to persons, or damage to customer's property, ever having been experienced as a result of a fire or explosion in a transformer vault.

Twelve companies reported a total of 63 cases of troubles in vaults of all descriptions, 39 of which caused no damage to the vault or any trouble outside the vault. The other 24 cases, experienced by seven companies, resulted in damage either to the vault or to property outside of the vault, or in personal injuries.

The 63 cases of trouble reported have been arranged in two groups including troubles in vaults deemed to conform with National Electrical Code requirements and troubles in vaults which were not in conformity with Code standards at the time the trouble occurred. A third group of troubles is also included which covers all known cases of trouble in vaults which occurred when the door was open and when men were working in the vault.

*Electrical equipment failures in which sufficient internal pressure was developed to rupture the case or tank have been classified as explosions. It should be understood, however, that in several of these instances there was no evidence of the vault having been subjected to an excessive pressure.

NOTE: This article is an abstract of a report on utility company experience presented at a joint meeting of the Accident Prevention Committee, Electrical Equipment Committee, and Transmission and Distribution Committee of the Edison Electric Institute, Chicago, Illinois, May 3, 1938.

Troubles in Vaults Deemed to Conform with Code Requirements.

A total of 45 cases of trouble were reported, 31 being network vaults and 14 non-network vaults. Of the 31 network vault troubles, two were faults in the low tension wiring, one was a pothead failure, and the remaining 28 cases were transformer failures. Of the 14 non-network vault troubles, nine were transformer failures, oil circuit breakers were responsible for four cases, and the remaining one was a bus short circuit.

Of the total of 45 vault troubles reported, no structural damage was done to the vault, and the vault was successful in safeguarding property and persons in 35 cases. This leaves 10 cases in which some unsatisfactory experience resulted. The nature of these experiences is indicated by the following explanations:

CASE 1. A transformer tank ruptured in a sidewalk vault and the clothing of a person on the sidewalk was burned.

CASE 2. A transformer tank ruptured in a sidewalk vault and two persons on the sidewalk were injured.

CASE 3. A transformer tank ruptured in a sidewalk vault, the clothing of one person on the sidewalk was burned and a store window broken.

CASE 4. A network switch and cable fire in a sidewalk vault broke a store window.

CASE 5. A pothead failed in a sidewalk vault and a store window was broken.

CASE 6. A transformer exploded in a vault on a public pier, blew the vault door off, burned the clothing of one person, and another person sustained a broken leg in the rush of the crowd to get off the pier.

CASE 7. An explosion of gas from decomposed insulation on low voltage cables in an unventilated cable chamber blew down an 8-inch brick wall. Falling bricks caused slight damage to the customer's switchboard.

CASE 8. Water dripping on a 13,200-volt bus resulted in an explosion which blew down an 8-inch brick wall. No damage was sustained outside the vault.

CASE 9. A transformer explosion slightly dislodged one of the 8-inch brick walls of the vault.

CASE 10. A transformer fire which occurred while some temporary work was in progress spread through an opening in a wall, which was to have been closed up but had been overlooked, causing a fire in the customer's basement.

Combining these experiences gives the following summary of personal injuries and property damage reported as resulting from the use of Code standard vaults. Property damage caused by smoke and water is not included.

Person sustained broken leg	1 case	1 person
Person injured by burns	2 cases	3 persons
Person's clothes burned	3 cases	3 persons
Plate glass window broken	3 cases	3 windows
Customer's property damage	1 case	by fire
	1 case	by falling brick
Structural damage sustained by vaults	1 case	8″ brick wall blown down
	1 case	8″ brick wall dislodged

Troubles in Vaults Which Did Not Conform with Code Requirements.

A total of 18 fires and explosions were reported to have occurred in vaults which did not comply with present Code standards at the time the failure occurred. These experiences include 11 transformer and seven oil circuit breaker failures. Sustained oil fires followed the electrical failure in 13 cases. Four failures occurred without any evidence of inadequacy of the vault. No fatalities were experienced. Personal injuries were sustained in two cases.

In one case a transformer exploded in a sidewalk vault which communicated with a department store basement. Vault ventilation ducts exposed in the basement were ruptured. There was no sustained fire. The explosion and resulting fumes caused a stampede of persons in the basement to reach the exits, and this resulted in minor injuries to several persons.

The other case was a transformer explosion in a vault in the basement of an apartment house. Parts of the vault walls were blown down and some material stored in the basement was damaged. Several persons on the floor above the vault sustained minor injuries, mostly as a result of falling plaster.

In the 18 cases of trouble in vaults in this classification, property damage outside the vault was limited to damage by smoke, water, and to broken windows and other minor damage in the immediate vicinity of the vault in all except four cases. In three cases for which figures are available, and which include the two cases of personal injuries mentioned above, claims for property damage and personal injuries totaled about $74,000. Of this amount $4200 covered personal injuries and the balance covered property damage.

Troubles Which Occurred While Men Were in the Vault.

In addition to the experiences described above, four cases are known in which serious trouble occurred in a vault at a time when men were working in the vault with the vault door open. These are the only known cases of loss of life associated with the operation of transformer vaults. Because of the circumstances under which these accidents occurred, they are not of interest as evidence of the adequacy of vault construction, but are included as a matter of record and as evidence of the importance of maintaining the best possible supervision over all work done in electrical equipment vaults.

CASE 1. An oil filled potential transformer exploded followed by an oil fire. A section of sidewalk which served as part of the roof of the vault, and which was not constructed according to Code requirements, was blown out. Two lives were lost in rescuing a child that fell into the vault. An electrician was fatally burned and other workmen received burns.

CASE 2. Six men were burned, two of them fatally, as a result of an explosion of a ground switch compartment attached to a transformer tank. Apparently the transformer was energized with the ground switch closed.

CASE 3. Five men were killed in an explosion resulting from an attempt to install a thermometer with metal stem in the transformer tank while the transformer was energized.

CASE 4. Six men were burned, three of them fatally, when a manually operated circuit breaker failed upon an attempt to close the breaker.

Dry Cleaning Plant Fire Record.

In 1935 there were about 57,000 dry cleaning and dyeing plants and pressing, alteration, and repair shops in the United States doing a business of about $350,000,000. It is estimated that there were 1100 fires in these occupancies involving losses of over $360,000 in 1935. Commercial dry cleaning has grown rapidly in the last 20 years—even the small towns now have at least one dry cleaning plant.

The importance of the special fire hazards in connection with the use of flammable liquids in dry cleaning plants is evident from the following record of 175 fires in these plants occurring in the fifteen-year period from 1923 to 1937. This record was compiled from reports of explosions and fires on file in the N.F.P.A. Department of Fire Record, and while it includes only a small fraction of the total number of explosions and fires, it is indicative of the general experience, especially of the more important fires. Owing to more complete reporting service on fires in sprinklered buildings, this record may perhaps be

Chicago, Ill., July 22, 1936. Five persons were killed and five others were injured, when a terrific explosion of an undetermined cause demolished this fur cleaning and dyeing plant.

somewhat unbalanced in not showing a greater number of fires in unsprinklered buildings.

Regulations for safeguarding dry cleaning and dry dyeing plants were first prepared by the N.F.P.A. Committee on Flammable Liquids in 1924 and 1925, in coöperation with the National Association of Dyers and Cleaners. A complete revised edition was issued in 1936. The fire record shows that nearly every fire loss of any consequence was largely the result of non-compliance with one or more of the provisions of these regulations.

Causes of Fires.

Obviously, the greatest hazard in dry cleaning plants is the presence of flammable and explosive vapors. As shown by the accompanying table, static sparks or friction inside the drying tumblers and washing machines are the most common sources of ignition.

Causes of Fires		No. of Fires
In drying tumblers		51
Static, metal, or friction	22	
Matches in clothing	8	
Thought to be either matches or friction	6	
Ignition of combustibles in vent from dryer	2	
Miscellaneous known causes	6	
Unknown causes	7	
In washing machines		31
Static, metal, or friction	17	
Static when moving clothes from washer to dryer	6	
Matches in clothing	4	
Miscellaneous known causes	2	
Unknown causes	2	
Other causes involving solvents		28
Careless handling of solvents	10	
Vapors, waste, etc., ignited by boiler fire	8	
Ignition of solvents while hand dry cleaning	5	
Vapors ignited by construction or repair operations	3	
Spilled solvents ignited by gas burners	2	
Electrical causes		18
Sparks from motors	5	
Flat irons left on	5	
Overheated motors	3	
Sparks from unprotected electric switch	2	
Short circuits in wiring	2	
Broken sight glass in washer and broken light bulb	1	
Exposure		5
Waste or residue from filter ignited outside building	3	
Rubbish outside ignited by spark from locomotive	1	
Roof ignited from outside spark	1	
Smoking—matches		5
Incendiary		5
Spontaneous ignition in waste, silk goods, rags		3
Careless operation or flare-back of oil burners		3
Defective heaters		3
Miscellaneous known causes		5
Unknown		18
Total		175

Gasoline and naphtha were the solvents used at the time of occurrence of about two-thirds of the fires, and Stoddard Solvent or various other high flash-point or "safety" solvents were involved in the remainder. This may indicate that gasoline and naphtha are still widely used, or more likely that the hazards of gasoline and naphtha are so much more serious than those of high flash-point solvents. The average loss per fire (where figures were available) was $5,600 where gasoline and naphtha were used, as compared with $1,450 where higher flash-point solvents were involved. The National Association of Dyers and Cleaners estimates that about 90 per cent of the dry cleaning plants using petroleum solvents have adopted within the past twelve years the use of Stoddard Solvent or other solvents having flash points above 100° F.

Construction of Plants.

There is some evidence of greater hazard in combined laundry and dry cleaning plants than in dry cleaning plants alone. The only two fires included in this record with losses over $25,000 each occurred in combined plants of brick and frame construction that were not sprinklered. (See story of one fire below under date of Jan. 6, 1937.) The reports of fires in combined plants generally indicate larger buildings, more valuable equipment, and more often brick and frame construction than in case of dry cleaning plants alone. Losses in combined plants that are sprinklered, however, are comparable to those in ordinary dry cleaning plants. The construction of the buildings involved was:

Construction of Plant	No. of Fires	Per Cent of Known Construction
Brick and frame:		
One story	21	15
Over one story	24	17
Not specified	23	16
Fire-resistive:		
One story	20	14
Over one story	5	3
Not specified	8	5
1-story concrete or concrete block	19	13
Frame	18	12
1-story brick, with tile or concrete	7	5
Total known construction	145	100
No data	30	
Total fires	175	

Fire Loss Data.

Property loss figures were given in the reports for 106 of the 175 fires in dry cleaning plants. The total loss in these fires was $410,620, or an average loss per fire of about $3,900. (There is evidence, however, from fire insurance statistics and N.F.P.A. estimates of fire losses by occupancy groups that the average loss for all dry cleaning plant fires is comparable with the national average of about $500 for all fires.)

Sixty-six of these 106 fires occurred in plants equipped with automatic sprinklers, causing a total loss of $53,170, or an average loss per fire of about $800. The 40 fires in plants not so equipped caused a total loss of $357,450, or an average loss per fire of about $8,900. Thus the average loss per fire in unsprinklered plants is more than eleven times that of fires in sprinklered plants.

The accompanying table shows the fires in sprinklered and unsprinklered plants classified according to the size of fires. Two-thirds of the fires in sprinklered plants caused losses of $500 or less each, while more than two-thirds of the fires in unsprinklered plants caused losses of over $500 each. There were only two fires in sprinklered plants resulting in losses of over $5,000 each as compared with 15 such fires in plants not equipped with sprinklers.

Loss	Sprinklered Plants		Unsprinklered Plants	
	No. Fires	Per Cent	No. Fires	Per Cent
$50 or less	10	15.1	4	10.0
$51 to $500	34	51.5	7	17.5
$501 to $1000	11	16.7	5	12.5
$1001 to $5000	9	13.7	9	22.5
$5001 to $10,000	1	1.5	7	17.5
$10,001 to $25,000	1	1.5	6	15.0
Over $25,000	0	0.0	2	5.0
Total	66	100.0	40	100.0

In 10 of the 175 fires, 15 persons lost their lives. Twelve of the deaths occurred in unsprinklered property and three in sprinklered property. In 25 fires, 49 persons were injured. Forty of these injuries occurred in fires in unsprinklered property and nine in fires in sprinklered property.

Automatic Sprinkler Operation.

As shown in the following table, automatic sprinklers satisfactorily controlled 95.5 per cent of the fires where sprinkler systems were a factor. This is an excellent record of performance, considering the seriousness of the hazards of this occupancy, and comparing this figure with that of all classes of sprinklered property, which is 96.1 per cent. The second table below, indicating the number of sprinkler heads opening, shows that one or two heads controlled 62 per cent of the fires.

Effect of Sprinklers	Dry Cleaning Plant Fires		All Classes of Sprinklered Property	
	No. Fires	Per Cent	No. Fires	Per Cent
Extinguished fire	32	72.8	42,025	70.1
Held fire in check	10	22.7	15,985	26.0
Total satisfactory control	42	95.5	59,010	96.1
Unsatisfactory	2	4.5	2,398	3.9
Total (sprinklers operating)	44	100.0	61,408	100.0
Sprinklers not a factor	48			
Total	92			

Number of Sprinkler Heads Opening	Dry Cleaning Plant Fires Number	Dry Cleaning Plant Fires Per Cent	All Classes of Property Per Cent
1	12	28.6	35.0
2	14	33.4	17.4
3	5	11.9	9.4
4 to 9	6	14.2	20.2
10 to 20	5	11.9	8.4
Over 20	0	0.0	7.5
Total (data available)	42	100.0	97.9
No data	2		2.1
Total	44		100.0

Following are the details of the two fires which were not satisfactorily controlled by automatic sprinklers.

NEW ORLEANS, LA., JUNE 19, 1923. Clothes were being cleaned with gasoline in a dry cleaning washing machine consisting of a revolving wooden cylinder inside of a metal cylinder with clearance of two inches or more at sides and ends. The attendant had the door of the outer cylinder open and was pouring in ammonia solution when the gasoline caught fire. Apparently static electricity had accumulated on the wooden cylinder (as all parts of the machine were not properly bonded and grounded) and discharged when the ammonia solution was poured into the machine. The heat from the fire fused a sprinkler head on the ceiling over the machine, and water from this sprinkler ran into the machine, floating burning gasoline on the floor. The heat banked on the ceiling and opened another sprinkler, but the hazard was too severe for the sprinklers, and the fire was extinguished with a foam type extinguisher. The machine was not damaged, but there was about $200 water damage to garments. (S-60849.)

WALTHAM, MASS., DEC. 1, 1937. Clothing which had been cleaned with a solvent having a flash point comparable to that of kerosene was being dried in a rotary metal dryer with a heat unit on top and a fan at the base which drew air from the drying chamber venting to the outside. Shortly after the dryer was started, an explosion occurred inside which blew off the door and bulged out the front of the dryer. The dryer was not properly grounded and a static spark ignited the vapors inside, causing the explosion. It was thought that the vent fan was not operating properly. Following the explosion, flames shot out of the door and vent opening. Employees removed garments near the dryer and pulled the public fire alarm box at the property. One employee practically extinguished the fire in the dryer with a 2½-gallon foam extinguisher. The dryer was equipped with a steam jet automatically controlled by a fusible link at side of upper chamber and another in the vent. The links operated and the steam jet opened, but the operation was not especially satisfactory, due to the openings made in the dryer by the explosion. A sprinkler head to one side of the dryer opened, while the one directly over the dryer did not open, probably because of draft conditions. The operation of the head that opened was not satisfactory because only a little water and thin mud came out, which soon plugged the head. The mud which clogged the piping had apparently been drawn in from the street water mains which had recently been replaced. In view of the location of this sprinkler in relation to the fire, which was largely

confined to the dryer, its proper operation probably would have had little effect on the fire. Eighteen panes of the large window at the back of the dryer were broken out by the flames, but the total damage was slight. (S-75073.)

Room Flooding or Smothering Systems.

Carbon dioxide room-flooding systems were involved in three fires. One fire occurred in a naphtha house and another in a dry cleaning washer room, both of which were instantly extinguished without damage by the manual operation of room-flooding systems. The third fire was burning solvent which had been spilled on the floor of a fire-resistive cleaning and dyeing plant. The carbon dioxide equipment and steam jets with which the building was equipped were used and smothered the fire.

Manually controlled steam smothering systems installed in dry cleaning and drying rooms were factors in seven fires. Two of the fires were satisfactorily controlled by steam jets alone, three were controlled by the steam in conjunction with sprinkler systems, and one was controlled with the help of a carbon dioxide room-flooding system. In such fires it is difficult to determine from the information available just which extinguishing system deserves the most credit for controlling the fire. The steam system did not satisfactorily control one fire because firemen arrived shortly after the steam was turned on and smashed the windows, allowing air to enter to nullify any smothering effect of the steam. (See story below under date of Oct. 6, 1925.) The average loss in these seven fires was about $2,500.

Steam has been the extinguishing agent specified for dry cleaning plant fire protection for many years, its use antedating the development of carbon dioxide and other special fire extinguishing methods. State laws or regulations generally specify steam extinguishing systems but recognize other suitable systems as an alternate. The National Association of Dyers and Cleaners estimates that more than 90 per cent of all plants using petroleum solvents are equipped with steam extinguishing systems. The record is not clear as to the relative extent of the use of steam for the protection of individual closed units where the steam may be employed most effectively, as contrasted with its use for general room protection, where the effectiveness of steam is limited by rapid condensation.

Steam and Carbon Dioxide Systems for Protection of Machines.

Automatically operated steam jets were factors in six fires in drying tumblers. In two of these fires the steam jets alone extinguished the flames, while in the other four fires the steam jets were assisted by hand fire extinguishers, largely because conditions did not permit satisfactory operation of the steam systems. In one fire the fuse link operated and opened the steam jet, but the fire was not controlled because of the openings made in the dryer by the explosion which caused the fire. Automatic steam jets at another fire were

operated by a fuse link, but apparently they were not entirely effective because of the delay in turning off the fan at the bottom of the dryer. The third fire was partly extinguished by the steam jet which was turned on manually after the automatic feature did not operate, either due to failure or because there was insufficient pressure on the explosion vents to operate it. In the fourth fire the dryer was equipped with automatic explosion hatches which actuate a steam jet, but the fire occurred without an explosion and the jet did not operate. The average loss in these six fires was about $600.

Manually operated steam jets in washing machines and drying tumblers were factors in twelve fires. The jets alone extinguished seven fires, while they were assisted by other equipment, generally foam extinguishers, in the other five fires. At one fire in a washing machine, the valves operating the steam jets were only eight to twelve feet from the machine and the fire was too intense to reach them. This fire was extinguished by automatic sprinklers and foam extinguishers. The average loss in these twelve fires was about $700.

There were no reports of fires involving the use of carbon dioxide extinguishing systems in machines as distinguished from carbon dioxide room-flooding systems. One explanation may be that fires in washers or dryers thus equipped were so quickly extinguished that they were not considered of sufficient importance to cause a report to be made.

Foam Systems and Extinguishers.

Foam generating systems successfully extinguished the three fires which occurred in rooms of dry cleaning plants that were so equipped. In one instance a fire occurred in the cleaning drum located in a one-story, fire-resistive unsprinklered building. The doors of the drum blew open and the fire spread to the solvent filtering tank, but employees used the foam generating system at the plant and extinguished the fire with a loss to building and equipment of $442. In another instance a fire started in a rubbish heap just outside the plant, but it was quickly extinguished by employees using a private hose line equipped with a foam generator. In the third fire in which foam generators were used, an employee was burned to death after a naphtha explosion trapped him in a small drying room. When firemen arrived the plant was a roaring furnace, and while it was not possible to save the man they soon extinguished the fire with their foam generating equipment.

Wheeled type foam units and the smaller type hand foam extinguishers were employed successfully by themselves or with the help of other equipment in 25 of the fires included in this record for which this information was given. Seventeen of these fires were in drying tumblers, five in washers, and three were in rooms but outside these machines. The use of foam extinguishers was not entirely effective in controlling two fires, probably because of the headway of the fire or because of improper handling.

Typical Dry Cleaning Plant Fires.

As indicated by the following typical examples of dry cleaning plant fires, failure to provide safeguards as set forth in the Regulations for Dry Cleaning and Dry Dyeing Plants prepared by the N.F.P.A. Committee on Flammable Liquids was a factor in nearly all of the large loss fires. After several of the more serious fires at plants using gasoline or naphtha, the fire reports indicated that plant owners started to use safer solvents. The frequency of fires in this occupancy is shown by the fact that eight of the dry cleaning plants had had three to seven fires each previous to the one covered in this record.

Firemen Nullify Effect of Steam by Breaking Windows.

MALDEN, MASS., OCT. 6, 1925. This was a modern 1-story fire-resistive cleaning plant. The main plant was sprinklered, but the detached cleaning section, where the fire occurred, was provided with only hand protection and steam jets served by a 2-in. steam pipe supplied by 75 lbs. steam pressure. Clothing had been cleaned with gasoline or naphtha, and as the clothing was being removed from a centrifugal extractor or dryer, the vapors caught fire, probably from static electricity. Employees ran from the building but closed all exit doors in leaving, and the owner was immediately notified and the fire department summoned. The owner ran from the main building and opened the steam valve which supplied the jets in the cleaning section. The steam system might have extinguished the fire, but firemen arrived shortly after it was turned on and smashed in the wired glass windows, which allowed air to enter and nullify any smothering effect of the steam. Firemen used six hose streams, which made the fire worse by spreading the blazing solvent to all parts of the room. Realizing the ineffectiveness of water, the fire department used several 40-gallon wheeled type and 2½-gallon hand type foam extinguishers, some of which were obtained from neighboring properties. Soon the fire was extinguished, but the loss by this time was about $12,000. (S-40523.)

Spot Cleaning with Gasoline, Employee Badly Burned.

LOWELL, MASS., JUNE 15, 1926. An employee was spot cleaning a fur collar to a coat with gasoline from an open dish when the gasoline ignited, probably by static electricity. Sufficient heat was produced to open two sprinkler heads, which put out the fire. The system was shut off immediately and very little water got through to the floor below. The employee was badly burned. The loss, estimated at $500, was confined to the coat and a basket of clothes. (S-42768.)

Six Violent Explosions Result from Non-Compliance with Regulations.

SAN FRANCISCO, CALIF., MARCH 2, 1929. Three employees were injured and a large part of a cleaning and dyeing plant was wrecked by a series of six violent explosions. The initial explosion originated by the ignition of solvent vapors which had accumulated in the boiler room. These vapors obviously came from the solvent on the floor at the still alcove and from the washroom, from which there was a draft. The owner of this plant had done practically nothing to comply with the regulations for safeguarding cleaning and dyeing plants made by the State Fire Marshal's office. (H-30285.)

Static from Furs in Dryer — Steam and Foam Control Fire.

BOSTON, MASS., APRIL 15, 1929. Garments had just been washed in naphtha and placed in a tumbler dryer. When the dryer was started a flash fire occurred. Static charges were thought to have been on the fur of winter coats. The tumbler was set on a concrete floor laid on the ground, and shafting above was not grounded. The fire was extinguished by a manually operated steam jet in the tumbler and by a 40-gallon wheeled-type foam extinguisher before the arrival of the fire department. There was no loss to building, but $2,691 loss to customers' clothing, and $654 loss to equipment. A similar fire occurred in another dryer of this plant about three weeks later. (H-29301.)

Sub-Standard Electrical Equipment in Dry Room.

ELIZABETHTOWN, TENN., MAY 29, 1929. Occasional washing with gasoline in a hand washer was done in a 1-story building with brick walls and concrete slab roof. Clothes had been cleaned in the washer, passed through a centrifugal extractor, and hung in the dry room, which did not have vapor-proof electrical equipment. When an employee turned on the light in the dry room an explosion blew out the wired glass windows, bulged out the brick walls and did some damage in other parts of the building (including a clothing store in the front section), but the heat released a fire door which confined the fire to the dry room. The explosion damage was about $1,500, and fire about $150. (H-27472.)

Automatic Steam Jet and Foam Control Fire.

MACON, GA., MARCH 5, 1930. Employees smelled paint burning on the outside of a tumbler dryer and heard the thermostatic control for the steam jet on the machine operate. They first closed the fire door leading to the remainder of the plant, then opened the door to the tumbler and turned in the contents of two foam extinguishers, although the steam from the automatically operated jet had practically extinguished the blaze. It is likely that the fire was caused by a match in the clothing. There was no explosion. About 14 suits of clothes were destroyed with a loss of about $380. (S-55753.)

Sprinklers Prevent Spread of Fire from Washer.

BIRMINGHAM, ALA., APRIL 16, 1930. Metal buttons striking the side of the washer are thought to have caused the explosion of gasoline vapors in a tumbler washer. The doors of the machine were blown open and the heat from the flaming clothing quickly opened three sprinkler heads over the machine. Water from these heads prevented the fire from spreading to the main part of the laundry and dry cleaning plant, and the fire in the machine was extinguished by the fire department, using chemicals. The machine and clothing in it were destroyed, with a loss of about $1,760. (S-51977.)

Delayed Response by Fire Department, Equipment Destroyed.

VERDUN, QUEBEC, FEB. 27, 1931. A light explosion occurred in a drum drying machine on the first floor of a 2-story brick-joisted dry cleaning building. A high flash-point solvent was used in this plant. The explosion may have been the result of static electricity, a piece of metal (such as a button) striking another, or dust or vapor becoming ignited by the heat from the steam coil. The door of the dryer blew open and the flames ignited the contents of an extractor close by. Employees used two 2½-gallon foam extinguishers, but the

Acme.

Brooklyn, N. Y., Sept. 10, 1935. Firemen fighting a fire in a small dry cleaning plant. The fire started in the show window where there was a washing machine containing about 40 gallons of low flash-point solvent. A disturbance in the window electric system apparently caused the explosion of fumes, which pocketed in the window.

flames spread quickly through the room and the fire department was called. The fire department did not respond for about 15 minutes, apparently because of some mistake in giving the address over the telephone. By this time the fire had passed through the unprotected doorway into the adjoining room and up the wooden stairway. The fire was controlled before it reached the solvent tank room on the second floor, but the dry cleaning equipment was practically destroyed. The loss was about $6,000. There had been four previous fires at this plant. (H-33117.)

Fire in Dryer, Stoddard Solvent.

BUFFALO, N. Y., MARCH 24, 1932. Suits and overcoats had been cleaned with Stoddard Solvent, and after going through a centrifugal dryer, were trans-

ferred to a steam-heated tumbler dryer. In about five minutes fire occurred in the dryer, probably from friction of hard materials or matches. The steam jets in the dryer were opened manually. Employees also discharged foam and soda-acid extinguishers into a roof vent, which was the only place the fire escaped the dryer. The loss was about $1200. (S-60690.)

Fires Started by Racketeers.

ALLENTOWN, PA., APRIL, 1932. Three similar fires occurred in one plant during April. Each fire or explosion occurred in a steam-heated tumbler dryer after the clothes had been cleaned in a high flash-point solvent and put through a centrifugal dryer. Employees extinguished the fires by opening the valve controlling the steam jet inside the dryer. The total loss in the three fires was $510. The cause of these fires was spontaneously flammable material, which had been inserted in the clothing by racketeers because the plant owner refused to join an alleged dry cleaners' organization and pay $250 annual dues and five per cent of the gross receipts. (S-60663, 4, 5.)

Spark from Zipper in Dryer, Steam Jet Controls Fire.

BOSTON, MASS., MARCH 13, 1935. Fire, thought to have been due to a spark from the metal part of a jacket "zipper," started in a tumbler dryer which was grounded. Heavy jackets had been washed in high flash-point solvent and were being dried at the time of the fire. The dry house was a detached fire-resistive building. The fire was confined to the dryer by a steam jet, which was promptly placed in operation by an employee. The damage was about $650. Six fires had occurred previously at this plant. (H-40088.)

Proprietor Ignores Warning and Loses Life.

PITTSBURGH, PA., JULY 16, 1935. A small fire due to a short circuit on a cleaning machine occurred in the basement of a dry cleaning plant, but was quickly extinguished by the fire department. Firemen opened a sewer in the basement to drain out the water. They warned the proprietor not to resume business until repairs had been made to electric wires which had the insulation burned off and until the gas line was inspected by authorities. Evidently he failed to heed the warning and resumed operations about one hour later. He was killed in the resulting explosion of cleaning fluid vapors. Windows were blown out in near-by buildings and two women were injured as the flames spread to the adjoining beauty shop. The property loss was about $500. (H-40013.)

Valves Controlling Steam Jets Too Near Washers.

IRVINGTON, N. J., AUG. 5, 1935. An overheated bearing in a washing machine ignited the solvent (having a flash-point similar to that of kerosene), which was being used in the machine to clean overalls. An employee immediately sent in an alarm to the fire department and then tried to extinguish the blaze with a vaporizing liquid type extinguisher. Sprinklers directly over the washer operated, the water from which caused the flaming solvent to overflow the washer and spread over the floor. Fifteen sprinklers on the first floor operated and the heat passed through unprotected floor openings and opened three heads on the second floor. The sprinklers held the fire in check until firemen extinguished it with foam type extinguishers. Steam jets in the washers could not be operated, as the valves were about ten feet from the machines and could

not be reached because of the heat from the fire. There was a loss to contents of about $111. This was the third fire in this plant in 18 months. (S-70731.)

Laundry and Dry Cleaning Plant, Delayed Discovery, $105,000 Loss.

COLUMBUS, OHIO, JAN. 6, 1937. A fire on the top floor of a 4-story brick-frame laundry and dry cleaning plant was not discovered until it was too severe to use the available fire extinguishers and standpipe and hose protection. The property was not equipped with an automatic fire alarm system. The watchman was notified of the fire about 10:45 P.M. by an outsider. The fire department was called and had responded with 15 pumpers after the fourth alarm was sounded. Just before the hose lines were brought into action, there was a series of small explosions, probably liquids used for spotting purposes, on the top floor. These explosions broke windows and scattered the fire, which soon came through the roof. Fire doors on openings in a brick division wall automatically closed and stopped the spread of the fire. The fire was fought for about four hours from roofs of adjoining buildings, from aerial ladders and turret nozzles on the ground. The cause of the fire was not determined. The loss to building was about $40,000, and to contents about $65,000. (H-41697.)

Butane Gas Explosion, George West, Texas.

Careless methods of transferring liquid butane from a tank truck into an obsolete and improperly installed underground tank resulted in an explosion and fire which killed four persons and injured twelve others in a restaurant at George West, Texas, on July 5, 1938. The private butane gas installation did not comply with the N.F.P.A. recommended good practice regulations. The monetary loss was about $6,700, both the restaurant and a dwelling about 50 feet away being completely destroyed. George West is a town of about 250 population located 83 miles south of San Antonio.

The restaurant was one story high, frame and stucco construction, with metal roof on wood rafters, and wood joisted floor. The dwelling, located 50 feet to one side, was of frame construction, one story high, with metal roof. A 250-gallon butane tank was located beneath the 4-inch concrete floor of a small storage room, enclosed on three sides and located at one corner of the restaurant. The top of the tank was about two feet below the surface of the floor, having earth fill around the tank, without concrete pit. This tank was installed underground in 1935, apparently having been assembled by a local welder. Previous to this time (before the small storage room was built) the tank had been installed aboveground adjacent to the building.

The tank was improperly designed, having flat instead of dished heads, was of lighter material than N.F.P.A. regulations specify, had an inside fill-

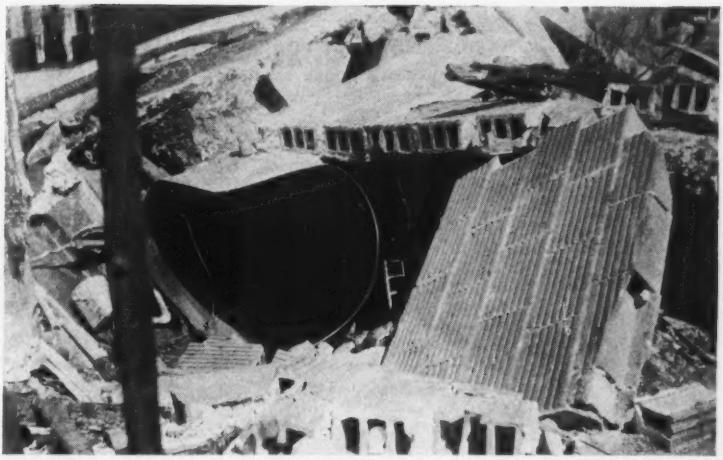
NOTE: This article was prepared from a detailed fire report issued by the Texas Inspection Bureau (Member N.F.P.A.).

Ruins of the restaurant after the underground butane tank (behind piece of metal roofing in foreground) exploded, resulting in the death of four persons.

pipe arrangement, and the welding appeared to be poorly done. It was not equipped with safety devices such as relief valve, back-pressure and excess flow valves, but had a contents gauge and a brass plate attached near the filling pipe, showing how the tank should be filled. The tank was designed to be filled by the gravity flow method, using two connections between the supply tank and underground tank to equalize pressure. The outside of the tank had not been treated to prevent corrosion, but it had corroded very little and was not believed to have been a contributing factor to the explosion. The tank truck apparently complied with the N.F.P.A. regulations for such vehicles.

The Story of the Fire.

To speed the filling of the tank it had been the practice of tank truck drivers to vent this underground tank to outside air, using the equalizing hose to convey the vapor to a distance considered safe. Adjacent occupants had objected to this gas, and in this particular instance the hose was not used. Although it was this driver's first visit to the premises, and it seems this installation had a reputation among tank truck drivers as being dangerous, the vapor was allowed to discharge into the small storage room adjoining and communicating through an open door with the kitchen, where gas burners were in operation. The storage room also communicated through an open window with the dish washing room, where a water heater was in operation. The cook objected to this method of filling, but the driver paid no attention and vapor continued to enter the restaurant rooms. The proprietor was absent at the time.



Close-up of the end of the sub-standard butane tank that ruptured while the tank was being filled.

While the underground tank was filling, the driver spent his time investigating the contents of an adjacent refrigerator and advising a local tire repair man who was changing a tire on the tank truck. Apparently the tank filled more quickly than he expected, perhaps due to high vapor pressure in the tank truck caused by several hours exposure to the hot sun. When the liquid began to flow from the vent, the driver rushed to look at the gauges and then to the tank truck to close the discharge valve. At this moment the vapor exploded, and fire forced the driver to leave before the discharge valve was completely closed. A second explosion followed the first. The source of ignition is not definitely known, but it is assumed to have been one of the five lighted burners in the restaurant, all of which were within close range.

The head was blown from one end of the tank and this end of the tank came out of the ground, demolishing the 4-inch concrete floor, the 18-inch concrete foundation, and the 8-inch hollow tile wall, as shown in the accompanying photographs. It is supposed that the tank was ruptured by high pressure from the tank truck. The roof of the restaurant was blown about 60 feet into the air. Apparently the entire restaurant building and the dwelling 50 feet away were filled with explosive vapor at the time of the explosion. Both buildings were on fire throughout immediately and were destroyed. Trees were burned at distances of 100 to 120 feet from the tank.

The local volunteer fire department responded at once with their hose truck and laid one line of hose. The volunteer department from Three Rivers arrived in 30 minutes and laid another line. The Beeville department arrived

in about an hour with the only pumper on the scene and laid two lines. There was ample water supply and the fire was limited without difficulty to the two buildings. Chemicals were used to extinguish the fire in the tank truck after it had been dragged into the open about 200 feet from its location at the time of the explosion. Safety valves on the tank truck had operated to relieve internal pressure, and the vapor burned as it escaped.

The tank truck driver, a dishwasher, and two customers (a woman and small daughter) were killed. Twelve other employees of the restaurant and customers were injured by the explosion and fire. The loss to buildings and contents was about $6,700.

Conclusions.

This underground tank was not only of obsolete and improper design, but the welding and other workmanship was imperfect. The installation was known among tank truck drivers to be a source of danger, but in spite of this the driver who was killed contributed to the hazard with his indifference to obvious safety measures.

Since September, 1937, all butane installations and tank trucks are required by state law to comply with the regulations of the Texas Railroad Commission, which are based on, and practically the same as, the N.F.P.A. regulations.

It has been reported that the company servicing this customer had given warning of the improper equipment and installation, but continued to give service as an accommodation. This accident should focus attention of the state on the need for condemning all remaining obsolete equipment, and of the butane industry on the desirability of refusing service to any equipment not up to the standard.

Fires and Fire Losses Classified, 1937.

By DeWayne E. Nolting,
N.F.P.A. Department of Fire Record.

Continuing the practice begun a year ago of showing the distribution of the annual fire loss in the United States and Canada by cause and occupancy classes, the N.F.P.A. Department of Fire Record presents the following tables covering the year 1937. Experience of the past year shows that these statistics are widely used in fire prevention and fire protection work.

The data upon which these tables are based were obtained from twelve state and six provincial fire marshals' reports for 1937. Reports of these particular states were chosen because they contained the most complete classifications. While methods of reporting and tabulating fire loss figures are different in each state, it is believed that the volume of statistics from the twelve typical states and six provinces included herein is sufficiently large to indicate the relative distribution of fires and fire losses for the various occupancies and causes.

Tables I to VI are tabulations made from fire marshals' reports. Table I shows the number of fires by occupancies, and Table II shows the fire loss by occupancies reported for the year 1937 in the twelve states. Tables III and IV show the number of fires and fire losses distributed according to causes. Tables V and VI show similar information for six provinces in Canada. The general classes making up both the occupancy and cause classifications were carefully chosen with regard to good practice and to classes most commonly used in the reports. Tables VII to IX are recapitulations and estimates for the entire United States and Canada based upon the first six tables and adding a certain percentage to cover unreported fires and losses as explained below.

Table VII is a recapitulation of the state and provincial totals presented in the foregoing tables, with columns added to show the number of fires per thousand population and the fire loss per capita. It will be observed that a total of 85,872 fires were reported in 1937 for the group of twelve states having a total population of 35,633,000 in the 1936 U. S. census estimate. A study of the best data available indicates that this number of fires is approximately half the actual number of fires for the year, and therefore 100 per cent has been added to get the estimate for the twelve states. When the resulting figure is applied to the whole country at the population ratio, the estimated number of fires in the United States in 1937 is 620,000. This makes 4.82 fires per thousand population, which is a little less than a similar figure of 5.24 for 1936 (October, 1937, QUARTERLY, page 158). As compared with the previous year, the total number of fires in 1937 was lower in ten of the twelve states.

Table I. Number of Fires by Occupancies in Twelve States — 1937.

Occupancy	Illinois	Indiana*	Iowa	Kansas	Louisiana	Massachusetts	Ohio	Oregon†	South Dakota*	Vermont	Washington†	Wisconsin	Totals
I. PUBLIC BUILDINGS													
Government buildings	2	8	3	10*a*	18*a*	34	....	19*a*	2	9	2	6	113
Hospitals and institutions	13	2	4	....	....	15	14	....	....	3	9	17	77
Schools	87	36	32	17	31	24	81	23	4	17	19	48	419
Churches	70	22	19	13	24	23	89	16	10	6	14	49	355
Theatres	37	12	19	14	11	15	40	22	10	1	13	18	212
Miscellaneous amusement bldgs.	61	23	21	....	....	88	79	....	5	11	30	45	363
II. DWELLING OCCUPANCIES													
Hotels and boarding houses	341	30	33	15	77	179	107	320	20	11	275	197	1,605
Apartments, rooming houses	2,049	74	104	....	....	....	1,098	....	....	....	327	127	3,779
Dwellings	6,278	2,705	2,806	1,912	2,316	5,274	10,514	3,610	367	1,660*b*	2,761	7,883	48,086
III. MERCANTILES													
Office buildings	138	31	44	....	....	135	109	....	8	....	29	54	548
Restaurants	295	37	95	....	....	93	136	74	....	....	73	56	859
Barber and beauty shops	29	....	19	....	....	9	20	....	3	....	10	10	100
Miscellaneous mercantiles	1,346	276	246	407	348	441	1,573	476	85	213	324	715	6,450
Storage warehouses	103	87	61	2	20	153	219	24	1	5	24	77	776
IV. MANUFACTURING													
Metal workers, foundries	31	9	41	13	4	32	3	15	8	3	24	61	244
Woodworkers, sawmills	30	....	14	1	13	12	....	59	....	13	46	11	199
Flour mills, elevators	23	22	14	11	7	....	....	5	7	1	1	20	111
Packing plants, smoke houses	26	1	12	....	....	....	10	....	....	....	10	26	85
Bakeries	38	5	14	....	....	17	24	....	....	2	14	29	143
Laundries	34	8	11	18*c*	....	16	65	....	3*c*	1	15	14	185
Dry cleaning plants, tailor shops	30	15	9	....	9	16	26	....	....	1	30	11	147
Miscellaneous manufacturing	430	125	43	36	116	401	646	137	9	23	58	236	2,260
V. MISCELLANEOUS BLDGS.													
Barns	477	394	278	....	....	188	381	155	104	....	77	414	2,468
Outbuildings	734	229	203	....	153	214	497	....	....	....	62	177	2,269
Lumber yards	18	6	2	2	3	9	44	....	....	....	5	16	105
Railroad, wharf property	29	21	9	....	....	33	....	....	5	....	7	10	114
Bulk oil storage, refineries	4	2	10	42	40*d*	....	....	16*d*	....	....	4	....	118
Garages, filling stations	961	230	258	22	22	289	1,278	39	46	27	77	347	3,596
Power plants, pump houses	18	7	12	17*e*	12	2	....	21	2	6	2	45	144
Miscellaneous	627	31	190	64	39	207	202	41	1	1	69	194	1,666
Outdoor fires	1,947	275	555	290	185	733	2,436	144	98	....	18	1,595	8,276
Totals	16,306	4,723	5,181	2,906	3,448	8,652	19,691	5,216	798	2,014	4,429	12,508	85,872

*Fiscal year ending June 30, 1937.
†Insurance losses only.
a. Includes hospitals.
b. Includes other farm buildings.
c. Includes dry cleaning plants.
d. Includes filling stations.
e. Includes railroad property.

Table II. Fire Loss by Occupancies in Twelve States — 1937.

Occupancy	Illinois	Indiana*	Iowa	Kansas	Louisiana	Massachusetts	Ohio	Oregon†	South Dakota*	Vermont	Washington†	Wisconsin	Totals
I. PUBLIC BUILDINGS													
Government buildings	$425	$2,137	$1,135	$23,706*a*	$70,394*a*	$59,045	....	$80,904*a*	$812	$12,155	$531	$3,258	$254,502
Hospitals and institutions	8,714	9,650	855	....	....	6,442	78,566	....	....	566	453	4,966	110,212
Schools	167,050	203,215	42,700	30,503	251,894	221,257	108,038	71,339	38,325	14,323	51,670	58,350	1,258,664
Churches	260,701	167,878	59,189	89,670	34,540	121,216	249,419	10,609	18,743	3,257	10,709	92,612	1,118,543
Theatres	72,836	2,518	13,759	9,934	85,721	149,815	6,749	45,125	7,258	244	30,631	24,637	449,227
Miscellaneous amusement bldgs.	77,404	40,059	66,376	....	....	263,984	107,937	....	2,653	6,377	50,446	56,355	671,591
II. DWELLING OCCUPANCIES													
Hotels and boarding houses	101,201	48,326	23,433	7,836	129,690	161,424	143,746	163,963	97,397	4,297	67,343	51,481	1,000,137
Apartments, rooming houses	356,627	33,472	48,451	....	....	....	549,480	....	....	....	66,516	11,154	1,065,700
Dwellings	2,859,680	1,574,390	1,500,519	1,120,844	815,347	3,724,585	2,953,168	765,525	311,585	830,122*b*	836,502	2,037,201	19,329,468
III. MERCANTILES													
Office buildings	136,449	16,271	32,491	....	....	793,208	41,661	....	2,670	....	28,516	11,711	1,062,977
Restaurants	299,341	50,861	171,133	....	....	205,745	110,558	19,058	....	....	53,948	20,161	930,805
Barber and beauty shops	11,443	....	5,741	....	....	13,736	1,400	....	507	....	232	4,202	37,261
Miscellaneous mercantiles	1,557,766	422,102	593,002	630,956	189,527	513,542	2,376,792	387,247	221,341	277,632	515,264	961,128	8,646,299
Storage warehouses	180,538	187,268	517,868	150	19,032	501,716	785,825	31,714	700	9,654	14,950	237,600	2,487,015
IV. MANUFACTURING													
Metal workers, foundries	303,620	5,057	21,847	36,057	80,914	130,643	399	19,236	3,540	54,943	9,754	353,440	1,019,450
Woodworkers, sawmills	29,678	....	11,326	50	34,062	5,930	....	658,894	....	30,927	162,645	6,091	939,603
Flour mills, elevators	141,800	146,347	72,197	47,245	10,875	....	....	10,573	37,082	19,473	2,393	120,162	608,147
Packing plants, smoke houses	5,057	400	18,501	....	....	....	239	....	....	....	16,676	5,880	46,753
Bakeries	250,710	2,535	6,418	....	....	25,844	7,703	....	....	31,593	3,324	3,645	331,772
Laundries	3,068	2,812	1,692	5,584*c*	....	63,195	12,921	....	1,982*c*	20	35,682	5,264	132,220
Dry cleaning plants, tailor shops	11,758	8,629	2,821	....	29,976	13,498	60,323	....	....	165	6,772	29,739	163,681
Miscellaneous manufacturing	1,859,860	486,031	228,611	151,763	85,494	1,532,097	1,590,902	494,274	5,379	49,565	112,685	406,375	7,003,036
V. MISCELLANEOUS BLDGS.													
Barns	789,732	766,682	469,866	....	....	300,038	600,725	159,959	111,152	....	61,266	772,331	4,031,751
Outbuildings	192,639	504,973	82,331	....	148,087	57,932	128,983	....	....	....	142,908	107,800	1,365,653
Lumber yards	189,680	3,120	91,335	8,000	155	87,030	204,662	....	....	....	48,091	33,750	665,823
Railroad, wharf property	15,255	19,980	1,874	....	....	106,458	....	....	7,980	....	44,374	28,722	224,643
Bulk oil storage, refineries	15,815	1,600	5,823	123,571	45,413*d*	....	....	60,261*d*	....	....	2,819	....	255,302
Garages, filling stations	425,057	102,166	110,609	142,753	29,630	151,655	307,908	20,086	22,180	11,146	20,993	120,829	1,465,012
Power plants, pump houses	34,235	2,176	1,968	9,131*e*	8,638	34,244	....	31,992	525	17,582	263	99,176	239,930
Miscellaneous	370,925	248,453	88,771	53,214	20,283	569,433	255,743	229,035	925	106	89,030	178,678	2,104,596
Outdoor fires	352,283	45,739	44,463	45,397	13,975	61,790	120,389	10,503	16,797	....	18,522	176,266	906,124
Totals	$11,081,347	$5,104,847	$4,337,105	$2,536,364	$2,103,647	$9,875,502	$10,804,236	$3,270,297	$909,533	$1,374,147	$2,505,908	$6,022,964	$59,925,897

*Fiscal year ending June 30, 1937.
†Insurance losses only.
a. Includes hospitals.
b. Includes other farm buildings.
c. Includes dry cleaning plants.
d. Includes filling stations.
e. Includes railroad property.

Table III. Number of Fires by Causes in Twelve States — 1937.

Cause	Illinois	Indiana*	Iowa	Kansas	Louisiana	Massachusetts	Ohio	Oregon†	South Dakota*	Vermont	Washington†	Wisconsin	Totals
Chimneys, flues—defective, overheated, soot burning	1,072	369	1,539	258	167	911	4,895	525	56	454	501	2,005	12,753
Sparks on roofs	2,335	564	....	305	271	....	....	456	....	42	170	....	4,143
Defective or overheated heaters	1,239	264	304	333	123	319	151	519	66	128	441	872	4,759
Rubbish	1,019	96	31	31	42	....	185	28	29	4	....	105	1,570
Combustibles near heaters	54	....	61	....	8	429	1,486	209	....	8	132	154	2,541
Open lights, flames, sparks	536	20	40	49	143	....	....	137	86	15	153	428	1,607
Hot ashes, coals	320	578	59	180	202	344	451	416	10	57	85	238	2,940
Oil burners	....	....	26	....	....	322	....	....	6	....	....	142	496
Careless smoking	2,471	242	379	231	595	2,232	2,547	1,388	57	292	888	2,083	13,405
Children playing with matches or fire	....	....	107	....	....	424	610	....	29	....	44	207	1,421
Other careless use of matches	....	129	56	....	....	355	809	....	11	....	90	386	1,836
Defective electric wiring	1,992*a*	361	406	289	195	922*a*	2,122	299*a*	71	95	210	1,060	8,022
Electric appliances, and motors	....	79	89	18	73	....	165	....	4	32	195	465	1,120
Flammable liquids, misc.; including home dry cleaning and starting fires	894	55	153	89	223	463	919	73	7	149	105	316	3,446
Torches, welding	....	26	56	....	....	72	271	....	10	....	16	64	515
Films, nitrocellulose	....	3	13	....	....	....	19	....	4	....	5	10	54
Lamps and stoves	....	91	281	....	....	59	365	....	55	....	23	489	1,363
Gas and appliances	180	10	4	65	78	15	167	....	3	2	....	103	627
Grease, tar, etc., on stoves	160	....	24	24	32	109	135	211	....	34	103	206	1,038
Spontaneous ignition	509	172	180	58	13	490	641	63	42	19	62	233	2,482
Fireworks	47	12	8	21	9	129	29	7	7	9	12	29	319
Lightning	231	179	109	50	135	100	216	26	21	189	31	1,398	2,685
Thawing pipes	....	5	22	....	....	7	55	....	....	....	24	11	124
Sparks from machinery, friction	19	16	56	28	59	34	74	41	8	3	15	54	407
Incendiary, suspicious	78	67	12	30	42	240	149	29	5	11	17	45	725
Miscellaneous known causes	461	76	336	52	21	268	1,467	18	30	7	243	325	3,304
Unknown	1,661	913	650	612	656	408	1,372	484	133	368	708	762	8,727
Explosions	454	177	....	76	32	....	....	50	22	8	20	62	901
Exposure	574	219	180	107	329	177*b*	391	236	26	88	136	256	2,542
Totals	16,306	4,723	5,181	2,906	3,448	8,652	19,691	5,216	798	2,014	4,429	12,508	85,872

*Fiscal year ending June 30, 1937.
†Insurance losses only.

a. Includes electric appliances and motors.
b. These fires are distributed according to causes above and therefore are indicated here but not added in again.

Table IV. Fire Loss by Causes in Twelve States — 1937.

Cause	Illinois	Indiana*	Iowa	Kansas	Louisiana	Massachusetts	Ohio	Oregon†	South Dakota*	Vermont	Washington†	Wisconsin	Totals
Chimneys, flues—defective, overheated, soot burning	$520,280	$312,346	$587,046	$174,279	$150,657	$583,411	$898,002	$151,973	$38,396	$128,689	$223,831	$911,420	$4,680,330
Sparks on roofs	606,774	152,492	....	91,327	109,427	....	....	170,787	....	19,541	56,284	....	1,206,632
Defective or overheated heaters	752,790	234,049	259,112	167,601	39,655	278,501	19,972	169,212	76,441	121,187	155,911	489,053	2,763,484
Rubbish	140,020	39,565	11,723	6,610	8,080	....	74,813	4,752	4,515	3,409	....	30,889	324,376
Combustibles near heaters	13,450	....	14,575	....	2,503	304,752	659,778	11,883	....	1,115	19,075	16,111	1,043,242
Open lights, flames, sparks	194,879	10,431	26,877	30,247	19,010	....	....	36,166	26,643	1,483	14,568	67,006	427,310
Hot ashes, coals	65,972	353,657	17,536	39,074	33,728	210,411	129,647	342,074	2,267	5,886	9,506	35,143	1,244,901
Oil burners	....	....	14,762	....	....	262,706	....	....	542	....	....	163,643	441,653
Careless smoking	339,246	108,545	111,718	41,425	114,715	1,795,738	664,206	148,198	24,871	38,877	141,890	266,128	3,795,557
Children playing with matches or fire	....	....	27,772	....	....	223,705	111,735	....	119,456	....	8,193	43,739	534,600
Other careless use of matches	....	43,377	19,940	....	....	252,462	193,473	....	9,144	....	15,391	38,561	572,348
Defective electric wiring	1,015,140*a*	581,436	298,607	255,844	36,330	1,366,997*a*	1,102,672	359,105*a*	84,132	66,761	123,743	968,139	6,258,906
Electric appliances, motors	....	36,108	30,906	4,538	14,856	....	88,124	....	4,383	19,376	22,839	65,089	286,219
Flammable liquids, misc.; including home dry cleaning and starting fires	503,405	66,742	62,367	125,224	127,813	281,217	144,814	22,167	2,464	94,686	65,533	79,464	1,575,896
Torches, welding	....	14,712	20,272	....	....	111,102	50,817	....	5,007	....	6,804	49,875	258,589
Films, nitrocellulose	....	1,015	14,317	....	....	....	1,747	....	1,134	....	1,840	13,106	33,159
Lamps and stoves	....	43,229	123,441	....	....	77,021	125,975	....	94,850	....	5,044	174,336	643,896
Gas and appliances	28,969	3,488	582	49,448	16,010	7,417	223,500	....	59	45	....	25,151	354,669
Grease, tar, etc., on stoves	32,713	....	3,969	8,665	1,824	71,672	95,370	11,864	....	2,590	17,506	21,205	267,378
Spontaneous ignition	445,573	407,274	227,971	142,078	25,209	872,868	339,865	54,272	100,783	24,167	74,675	355,984	3,070,719
Fireworks	5,447	4,833	6,705	6,868	2,290	27,903	3,796	491	1,765	2,009	1,256	5,362	68,725
Lightning	216,207	266,462	133,227	221,531	75,310	55,259	208,401	7,050	30,233	105,033	22,464	339,593	1,680,770
Thawing pipes	....	4,075	4,060	....	....	2,338	6,105	....	....	....	3,209	2,283	22,070
Sparks from machinery, friction	35,803	6,171	39,161	35,937	22,820	36,137	39,559	19,970	1,625	24,227	43,670	75,451	380,531
Incendiary, suspicious	107,306	83,192	13,903	12,651	88,841	580,388	113,679	65,919	3,913	23,930	22,196	41,968	1,157,886
Miscellaneous known causes	414,575	26,683	53,715	19,780	4,705	158,986	616,394	4,322	13,285	811	80,258	112,362	1,505,876
Unknown	4,924,911	2,140,587	1,902,720	859,162	1,106,007	2,314,511	4,372,058	1,426,488	210,913	639,150	1,274,017	1,281,465	22,451,989
Explosions	244,521	90,228	....	165,945	7,000	....	....	36,228	22,938	2,378	29,505	122,602	721,345
Exposure	473,366	74,150	310,121	78,130	96,857	173,523*b*	519,734	227,376	29,774	48,797	66,700	227,836	2,152,841
Totals	$11,081,347	$5,104,847	$4,337,105	$2,536,364	$2,103,647	$9,875,502	$10,804,236	$3,270,297	$909,533	$1,374,147	$2,505,908	$6,022,964	$59,925,897

*Fiscal year ending June 30, 1937.
†Insurance losses only.

a. Includes electric appliances and motors.
b. This loss is distributed according to causes above and therefore is indicated here but not added in again.

Table V. Fires and Losses by Occupancies in Six Provinces — 1937.

Occupancy	British Columbia		New Brunswick		Nova Scotia*		Ontario		Quebec		Saskatchewan		Totals	
	No. Fires	Loss	No. Fires	Loss	No. Fires	Loss	No. Fires	Loss	No. Fires	Loss	No. Fires	Loss	No. Fires	Loss
I. Public Buildings														
Government buildings	7	$5,445	4	$830	1	$115	9	$16,024	24	$44,076	3	$60,715	48	$127,205
Hospitals and institutions	14	1,939	....	....	....	....	....	....	11	2,798	7	4,773	32	9,510
Schools	17	74,940	19*a*	6,960*a*	18*a*	12,534*a*	82*a*	46,240*a*	70	265,872	31	32,507	237	439,053
Churches	5	6,291	9	61,580	5	1,025	83	304,811	53	246,646	....	....	155	620,353
Theatres	4	515	10	7,436	2	835	17	48,360	7	2,422	....	....	40	59,568
Miscellaneous amusement bldgs.	30	48,010	7	22,407	14	40,643	98	166,841	42	44,128	21	30,225	212	352,254
II. Dwelling Occupancies														
Hotels and boarding houses	108	92,750	11	748	22	17,106	236	290,304	233	239,764	25	5,364	635	646,036
Apartments, rooming houses	192	26,233	4	1,844	3	3,588	349	68,107	391	91,560	19	15,175	958	206,507
Dwellings	1,869	490,414	822	495,882	1,259	481,830	11,104	2,264,323	16,505	2,653,469	506	240,927	32,065	6,626,845
III. Mercantiles														
Office buildings	18	63,096	2	3,876	4	1,050	78	32,659	48	32,909	17	21,345	167	154,935
Restaurants	14	1,587	....	....	....	....	....	....	54	27,605	12	18,573	80	47,765
Barber and beauty shops	1	10	....	....	....	....	....	....	....	....	5	790	6	800
Miscellaneous mercantiles	147	98,230	67	116,446	74	360,703	1,085	1,501,613	437	533,810	55	105,828	1,865	2,716,630
Storage warehouses	1	33	....	....	....	....	....	....	58	403,596	31	63,552	90	467,181
IV. Manufacturing														
Metal workers, foundries	17	5,041	....	....	....	....	....	....	34	84,627	11	7,007	62	96,675
Woodworkers, sawmills	53	429,435	23	46,772	....	....	....	....	14	102,699	....	....	90	578,906
Flour mills, elevators	....	....	0	0	0	0	4	31,113	1	496	13	63,583	18	95,192
Packing plants, smoke houses	1	11,222	....	....	....	....	....	....	....	....	1	169	2	11,391
Bakeries	2	637	....	....	....	....	....	....	....	....	2	12,532	4	13,169
Laundries	3	564	....	....	....	....	....	....	18*b*	27,877*b*	2	325	23	28,766
Miscellaneous manufacturing	41	608,835	10	15,695	70	187,515	483	1,586,498	203	585,422	9	8,316	816	2,992,281
V. Miscellaneous Bldgs.														
Barns	39	49,094	42	45,994	100	131,493	640	1,188,051	646	508,840	71	48,601	1,538	1,972,073
Outbuildings	60	8,755	....	....	30	27,010	138	64,852	72	47,698	32	5,181	332	153,496
Lumber yards	4	2,025	6	5,665	3	7,433	15	36,116	11	54,163	2	750	41	106,152
Railroad, wharf property	5	9,601	4	63	1	45,675	28	67,810	....	....	1	326	39	123,475
Garages, filling stations	49	20,918	7	16,740	23	7,774	252	126,113	77	121,206	30	13,423	438	306,174
Power plants, pump houses	6	27,985	....	....	....	....	....	....	....	....	1	667	7	28,652
Miscellaneous	34	23,519	11	10,488	53	32,315	132	253,531	304	376,252	15	4,516	549	700,621
Outdoor fires	268	36,954	4	6,365	111	27,554	20	41,633	1	1,485	16	1,711	420	115,702
Totals	3,009	$2,144,078	1,062	$865,791	1,793	$1,386,198	14,853	$8,134,999	19,314	$6,499,420	938	$766,881	40,969	$19,797,367

*Fiscal year ending Nov. 30, 1937.

a. Includes hospitals.

b. Includes dry cleaning plants.

Table VI. Fires and Losses by Causes in Six Provinces — 1937.

Cause	British Columbia		New Brunswick		Nova Scotia*		Ontario		Quebec		Saskatchewan		Totals	
	No. Fires	Loss	No. Fires	Loss	No. Fires	Loss	No. Fires	Loss	No. Fires	Loss	No. Fires	Loss	No. Fires	Loss
Chimneys, flues — defective, overheated, soot burning	442	$245,671	193	$137,258	200	$140,304	823	$346,801	1,915	$218,986	65	$33,229	3,638	$1,122,249
Sparks on roofs	....	....	120	43,354	413	60,826	254	97,223	174	45,236	....	....	961	246,639
Defective or overheated heaters	263	94,835	110	30,531	172	119,388	1,491	915,904	2,136	369,753	94	57,317	4,266	1,587,728
Rubbish	....	....	3	196	0	0	54	22,493	20	9,535	12	2,476	89	34,700
Combustibles near heaters	67	9,873	47	23,848	95	155,586	950	338,635	86	37,132	2	1,698	1,247	566,772
Open lights, flames, sparks	335	54,676	47	5,948	45	11,750	455	86,098	521	96,446	35	13,426	1,438	268,344
Hot ashes, coals	57	7,169	12	1,445	22	8,881	277	51,606	1,183	54,473	24	5,453	1,575	129,027
Careless smoking	803	57,423	147	20,475	161	132,612	3,516	683,287	7,406	550,104	110	28,723	12,143	1,472,624
Children playing with matches or fire	48	2,693	....	....	....	....	....	....	....	....	29	3,907	77	6,600
Other careless use of matches	43	786	50	24,814	46	7,483	876	122,761	....	....	11	1,152	1,026	156,996
Defective electric wiring	154	96,121	57*a*	225,483*a*	64*a*	116,293*a*	1,340*a*	668,097*a*	581	336,711	30*a*	19,322*a*	2,226	1,462,027
Electric appliances and motors	120	17,646	....	....	....	....	....	....	709	27,527	....	....	829	45,173
Flammable liquids, misc.; including home dry cleaning and starting fires	128	69,440	2	1,226	27	35,434	429	637,991	317	143,697	53	45,321	956	933,109
Torches, welding	17	128,231	....	....	....	....	....	....	....	....	2	16	19	128,247
Gas and appliances	10	488	3	70	0	0	127	20,487	111	6,700	....	....	251	27,745
Grease, tar, etc., on stoves	40	4,584	14	9,291	20	4,816	291	78,749	234	44,085	....	....	599	141,525
Spontaneous ignition	19	36,890	9	64,884	14	7,938	173	441,522	124	92,987	38	36,268	377	680,489
Fireworks	18	1,083	4	1,263	1	10	104	14,142	35	1,995	....	....	162	18,493
Lightning	6	19,885	54	40,129	51	24,940	779	274,599	389	223,355	34	17,105	1,313	600,013
Sparks from machinery, friction	13	19,298	6	24,226	1	456	121	197,362	42	76,166	1	107	184	317,615
Incendiary, suspicious	48	123,946	11	18,670	34	28,614	120	317,277	24	19,938	24	17,515	261	525,960
Miscellaneous known causes	35	14,369	28	13,881	162	168,162	151	47,247	257	97,419	7	3,953	640	345,031
Unknown	282	1,119,450	120	134,329	220	343,427	2,280	2,603,617	2,423	3,497,657	290	317,002	5,615	8,015,482
Explosives	3	554	8	15,463	4	1,356	128	104,028	134	95,601	....	....	277	217,002
Exposure	58	18,967	17	29,007	41	17,922	114	65,073	493	453,917	77	162,891	800	747,777
Totals	3,009	$2,144,078	1,062	$865,791	1,793	$1,386,198	14,853	$8,134,999	19,314	$6,499,420	938	$766,881	40,969	$19,797,367

*Fiscal year ending Nov. 30, 1937

a. Includes electric appliances and motors.

Only 25 per cent was added to the number of fires reported in Canada because of the more complete reporting procedures employed in the provinces. The number of fires in Canada per thousand population increased from 5.17 in 1936 to 5.48 in 1937.

The estimated total fire loss of $270,000,000 in the United States in 1937 was obtained by applying the population ratio to the total loss in the twelve states and adding 25 per cent for unreported losses, which appears to be a reasonable procedure. This figure is about 11 per cent less than the corresponding figure of $303,700,000 for 1936. The Canadian loss of $22,746,058 in 1937 is slightly higher than the $21,549,484 loss in 1936.

Table VIII shows the total estimated number of fires and fire losses distributed by occupancies and based on the data in the previous tables. Table IX shows similar figures by causes. These occupancy and cause classifications are not listed in any order of importance, but are grouped so that similar classes come together. Each class is broad in scope in order to reduce the

Table VII. Fires per 1000 Population and Fire Loss per Capita for the Twelve States and Six Provinces — 1937.

State	Population (1936 Census estimate)	Number Fires	Fires per 1000 Population	Fire Loss	Fire Loss per Capita
Illinois	7,845,000	16,306	2.08	$11,081,347	$1.41
Indiana	3,459,000	4,723	1.37	5,104,847	1.48
Iowa	2,543,000	5,181	2.04	4,337,105	1.70
Kansas	1,886,000	2,906	1.54	2,536,364	1.34
Louisiana	2,122,000	3,448	1.62	2,103,647	.99
Massachusetts	4,425,000	8,652	1.95	9,875,502	2.23
Ohio	6,713,000	19,691	2.92	10,804,236	1.61
Oregon	1,017,000	5,216	5.15	3,270,297	3.22
South Dakota	692,000	798	1.15	909,533	1.31
Vermont	380,000	2,014	5.29	1,374,147	3.61
Washington	1,643,000	4,429	2.70	2,505,908	1.52
Wisconsin	2,908,000	12,508	4.31	6,022,964	2.07
Total	35,633,000	85,872	2.41	$59,925,897	$1.68
Estimated U. S. Total	128,429,000	620,000	4.82	$270,000,000	$2.10
Province					
British Columbia	751,000	3,009	4.00	$2,144,078	$2.85
New Brunswick	440,000	1,062	2.41	865,791	1.96
Nova Scotia	542,000	1,793	3.32	1,386,198	2.56
Ontario	3,711,000	14,853	4.00	8,134,999	2.19
Quebec	3,135,000	19,314	6.15	6,499,420	2.07
Saskatchewan	939,000	938	1.00	766,881	.82
Total	9,518,000	40,969	4.32	$19,797,367	$2.08
Est'd. Canadian Total	11,120,000	61,000	5.48	$22,746,058*	$2.04*

*Data supplied by J. Grove Smith, Dominion Fire Commissioner.

Table VIII. Estimated Distribution of Fire Losses by Occupancies — 1937.

These estimated figures are intended to show the relative order of magnitude of fire losses by occupancies, and while they are reasonable approximations based on the experience in typical states and provinces they should not be taken as exact records for each class.

Occupancy	United States		Canada	
	No. of Fires	Loss	No. of Fires	Loss
I. Public Buildings				
Government buildings	700	$950,000	70	$145,000
Hospitals and institutions	600	700,000	90	35,000
Schools	3,000	5,600,000	310	480,000
Churches	2,500	4,900,000	270	820,000
Theatres	1,500	2,100,000	70	80,000
Miscellaneous amusement buildings	2,700	3,900,000	320	405,000
II. Dwelling Occupancies				
Hotels and boarding houses	10,600	4,100,000	950	743,000
Apartments, rooming houses	41,000	5,600,000	1,440	237,000
Dwellings	338,000	87,000,000	47,900	7,610,000
III. Mercantiles				
Office buildings	4,700	5,700,000	250	178,000
Restaurants	7,900	5,200,000	120	105,000
Barber and beauty shops	1,300	230,000	30	3,000
Miscellaneous mercantiles	37,200	34,900,000	2,600	2,800,000
Storage warehouses	5,800	11,200,000	250	970,000
IV. Manufacturing				
Metal workers, foundries	1,700	4,300,000	180	180,000
Woodworkers, sawmills	1,600	4,900,000	250	1,200,000
Flour mills, elevators	900	3,100,000	30	120,000
Packing houses, smoke houses	1,100	300,000	10	30,000
Bakeries	1,300	1,400,000	20	35,000
Laundries	1,500	600,000	60	53,000
Dry cleaning plants, tailor shops	1,300	920,000	...	.....
Miscellaneous manufacturing	13,700	28,100,000	900	2,600,000
V. Miscellaneous Buildings				
Barns	20,200	21,600,000	2,300	2,220,000
Outbuildings	19,600	7,800,000	550	170,000
Lumber yards	800	3,700,000	70	123,000
Railroad, wharf property	1,100	1,400,000	70	160,000
Bulk oil storage, refineries	1,000	1,600,000	...	.....
Garages, filling stations	25,700	6,600,000	630	352,000
Power plants, pump houses	900	1,100,000	30	90,000
Miscellaneous	9,100	6,400,000	600	670,000
Outdoor fires	61,000	4,100,000	630	132,000
Estimated total	620,000	$270,000,000	61,000	$22,746,000

Note: As explained in the text, 100 per cent has been added in estimating the number of fires in the United States and 25 per cent in Canada; and 25 per cent has been added to the losses in the United States to cover unreported losses.

Table IX. Estimated Distribution of Fire Losses by Causes — 1937.

These estimated figures are intended to show the relative order of magnitude of fire losses by causes, and while they are reasonable approximations based on the experience in typical states and provinces they should not be taken as exact records for each class.

Cause	United States		Canada	
	No. of Fires	Loss	No. of Fires	Loss
Chimneys, flues — defective, overheated, soot burning	84,600	$20,100,000	5,300	$1,250,000
Sparks on roofs	55,000	9,200,000	1,900	410,000
Defective or overheated heaters	33,000	12,500,000	6,300	1,800,000
Rubbish	14,000	1,700,000	160	48,000
Combustibles near heaters	20,700	5,900,000	1,860	650,000
Open lights, flames, sparks	11,300	2,200,000	2,100	305,000
Hot ashes, coals	18,500	5,100,000	2,300	148,000
Oil burners	8,500	4,500,000	....	.....
Careless smoking	96,600	17,100,000	18,100	1,690,000
Children playing with matches or fire	17,000	4,200,000	350	22,000
Other careless use of matches	21,200	3,900,000	1,800	210,000
Defective electric wiring	45,000	23,500,000	2,800	1,180,000
Electric appliances, motors	19,000	5,800,000	1,750	550,000
Flammable liquids, misc., including home dry cleaning and starting fire	24,800	7,100,000	1,400	1,070,000
Torches, welding	6,300	1,900,000	80	410,000
Films, nitrocellulose	700	300,000	....	.....
Lamps and stoves	15,800	4,800,000	....	.....
Gas and appliances	5,200	1,900,000	440	37,000
Grease, tar, etc., on stoves	8,400	1,400,000	1,000	190,000
Spontaneous ignition	15,700	13,800,000	560	780,000
Fireworks	2,300	310,000	280	25,000
Lightning	19,300	7,600,000	1,970	690,000
Thawing pipes	1,700	190,000	....	.....
Sparks from machinery, friction	2,900	1,700,000	280	366,000
Incendiary, suspicious	5,300	5,100,000	390	605,000
Miscellaneous known causes	18,000	4,700,000	900	360,000
Unknown	27,000	90,000,000	7,300	8,800,000
Explosions	7,000	3,800,000	480	290,000
Exposure	15,200	9,700,000	1,200	860,000
Estimated total	620,000	$270,000,000	61,000	$22,746,000

NOTE: As explained in the text, 100 per cent has been added in estimating the number of fires in the United States and 25 per cent in Canada; and 25 per cent has been added to the losses in the United States to cover unreported losses.

number of classes to a minimum and permit the compilation of a sufficient amount of data on each to be of value. The best fire marshals' reports use much longer lists of occupancies and causes by subdividing the general classes such as those shown in the accompanying tables. It is desirable, for example, to divide the occupancy class "Dwellings" into "City Dwellings" and "Farm Dwellings," and the cause class "Lightning" into "Rodded" and "Unrodded"

classes, which is the practice in a few of the states and provinces. Some of the figures for Canada are missing from these two tables because the reports did not contain sufficient data on those particular occupancies or causes.

To arrive at the estimates shown in Tables VIII and IX the procedure outlined above was applied to the figures for each class in previous tables, except for those classes where data were lacking from one or more states. In such instances proportional increases in the total estimates were made. For example, three states did not give figures for fires in "Barns," and the total number of barn fires and losses was therefore increased by about one-third the total reported by the nine states. A corresponding reduction was then made in other classes; in this particular example the "Outbuildings" and "Miscellaneous" classes were reduced, as it is likely that the three states used these classes for recording barn fires.

Taking another example, five states did not report the number of fires or amount of the fire loss due to the cause "Sparks on roofs." Accordingly the totals reported by the other seven states were nearly doubled, and corresponding reductions were apportioned among the classes "Chimneys—flues" and "Miscellaneous known causes," under which it is assumed that the five states might have recorded fires caused by sparks on roofs.

As previously emphasized, these fire experience figures are approximate estimates, but give a fair indication of the distribution of losses by occupancy and by cause classifications, and are the most reliable data available.

Fires in Which There Was Loss of Life.

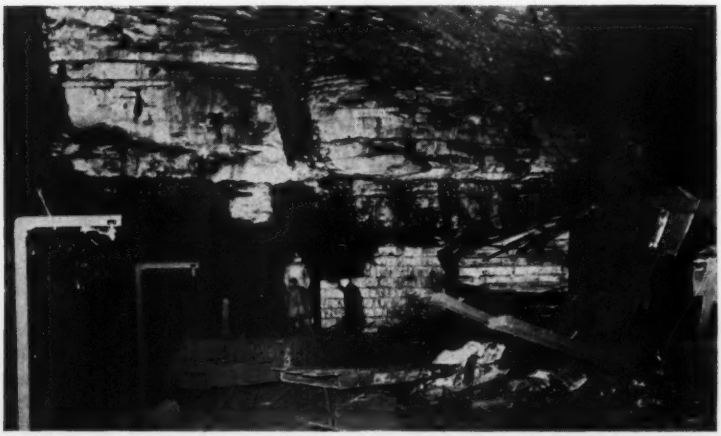
Second and Third Quarters, 1938.

Since the publication of the April QUARTERLY, the N.F.P.A. Department of Fire Record has received from various sources 262 reports of fires in which there was loss of life. A total of 539 lives were lost in these fires. During the period the following fires were reported in the United States and Canada which caused the loss of more than five lives each.

APRIL 4, 1938, NEW ORLEANS, LA. Six men lost their lives and 16 others were injured as a result of a dust explosion in a large fire-resistive grain elevator during the handling of corn. (July QUARTERLY, page 57. H-42492.)

APRIL 6, 1938, CHICAGO, ILL. A low rate lodging house known as the Center Hotel, and called by authorities a fire trap, burned in the early morning when most of the lodgers were asleep. Eight men did not awaken early enough to make their escape, and perished in the flames. The worst snowstorm of the season made fire fighting and rescues difficult. (H-42486.)

APRIL 22, 1938, near GRUNDY, VA. In a small mine workmen were using explosives fired from the mine power wires to break up some roof rock which had fallen, and which was too heavy to handle until it had been broken. The first blast set off a coal dust explosion that extended throughout the mine and killed every one of the forty-five men who were in it. (H-42487.)



Acme.

A view of the wreckage caused by a dust explosion in a bituminous coal mine near Grundy, Va., which was fatal to 45 miners on April 22.

Loss of Life Fires, April-September, 1938.*

This is a typical rather than a complete record, presented to show the conditions under which loss of life occurs, that they may be known and guarded against. The total loss of life by fire in the United States is estimated at 10,000 annually.

Class of Fire	Fires	Men	Women	Children	Total
Airplanes	12	34	8	2	44
Amusement places	1	0	1	0	1
Apartments, rooming houses, tenements, hotels	28	46	19	12	77
Automobiles, buses, trucks, motorcycles	19	29	12	6	47
Tank truck fires	2	5	1	0	6
House trailer fires	3	0	0	4	4
Barracks	1	1	0	0	1
Barns and stables	3	2	0	2	4
Brewery	1	5	0	0	5
College fraternity house	1	1	0	0	1
Dwellings—Rural	39	16	20	41	77
Dwellings—Urban	59	32	20	18	70
Forest or brush fires	5	6	1	0	7
Garages	2	2	0	0	2
Gasoline filling station	1	0	1	1	2
Gas well	2	2	0	0	2
Grain elevators	2	8	0	0	8
Institutions	2	2	0	0	2
Manufacturing occupancy, miscellaneous	11	13	2	0	15
Mercantile occupancy, miscellaneous	5	5	0	0	5
Mining property	12	86	0	0	86
Oil refinery	4	9	0	0	9
Oil well	2	4	0	0	4
Out of doors	15	4	2	9	15
Railroad rolling stock	1	1	0	0	1
Response to alarms	6	8	0	0	8
Restaurants	3	3	2	1	6
Sheds and outbuildings	3	2	0	1	3
Ships and boats	6	7	3	1	11
Tank vessels and barges	2	3	0	0	3
Theatre	1	1	0	0	1
Warehouses	2	6	0	0	6
No data	6	5	0	1	6
Totals	262	348	92	99	539

*This table is made up from those reports received by the Department of Fire Record between April 1, 1938, and September 10, 1938. A few of the fires included herein occurred prior to April 1, but were not reported until subsequent to that date.

APRIL 27, 1938, POTTSVILLE, PA. A cave-in at an anthracite mine released flammable gases from some unused workings. The gas was exploded when a miner with an acetylene cap lamp entered the area. He was killed and further quantities of gas were liberated by the explosion. A second explosion occurred 15 minutes later which was fatal to seven more men, most of whom were making a hasty exit from the mine. (H-42488.)

MAY 11, 1938, POOLE, KY. A tenant farmer, his wife and four of their children were burned to death when fire destroyed their home. One child escaped. (L-4403.)

MAY 16, 1938, ATLANTA, GA. Thirty-five persons were fatally burned or

overcome by smoke when the five-story Terminal Hotel burned. (See July QUARTERLY, page 46.) (H-42489.)

MAY 16, 1938, SAUGUS, CAL. A large transport plane being delivered to St. Paul, Minn., from Los Angeles, crashed into mountains 27 minutes after it had left the airport in Los Angeles. All nine occupants of the plane were killed either in the crash or in the resulting fire. (H-42490.)

MAY 24, 1938, INDEPENDENCE VILLAGE, OHIO. A commercial transport plane with nine men and one woman aboard caught fire in the air only eight miles from the airport in Cleveland for which it was heading, and crashed. All ten were killed. (H-42491.)

JUNE 2, 1938, near SCRANTON, PA. A rock fall in an anthracite mine shut off ventilation to a section almost a mile down. Gases accumulated and were ignited either from miners' lamps or sparks from motors. The explosion was fatal to ten miners. (H-42493.)

JUNE 10, 1938, DELAVAN, ILL. An army bombing plane flying through an electrical storm is reported to have burst into flame and crashed. Eight men were killed. (H-42494.)

SEPTEMBER 3, 1938, COVENTRY, VT. Six young men were killed when the automobile in which they were riding crashed and burst into flames. (H-42495.)

Foreign Fires

Several outstanding loss of life fires outside the United States and Canada have been reported during the period of this record. Foreign fires are not included in the tables. The most important are summarized below.

APRIL 11, 1938, SAO PAULO, BRAZIL. When hoaxers shouted "fire," 2500 spectators stampeded from an overcrowded motion picture theatre and trampled 31 children to death.

APRIL 30, 1938, FOGIA, ITALY. An Italian seaplane flying to Rome crashed into a mountain in a heavy fog and immediately burst into flame. Those not killed outright by the crash lost their lives by fire, which gave them no chance to escape. Eighteen men and one woman were killed.

MAY 10, 1938, DUCKMANTON, DERBYSHIRE, ENGLAND. Two explosions in a coal mine were fatal to a total of 80 miners. The second explosion occurred about two hours after the first and killed many engaged in rescue work.

JUNE 6, 1938, MALAMEC LA UNION, PHILIPPINES. More than twenty people were burned to death when lightning struck and ignited two flimsy dwellings in which a wedding party was being held.

JULY 7, 1938, COIMBRA, PORTUGAL. A local fire brigade built a four-story frame building and sprayed it with oil. They planned to use it in a fire fighting demonstration. Many young boys were put in the building to act as tenants who would be rescued. The fire department then retreated to await the alarm. The building was prematurely ignited, and burned so ferociously that it was

Causes of Loss of Life, April-September, 1938.

Fatalities classified according to the immediate cause of the loss of life rather than according to the cause of the fire.

Class of Fire	Men	Women	Children	Total
Airplane crashes and fires	34	8	2	44
Automobile, bus, truck collisions and fires	28	12	6	46
Collision of automobile with tank truck	3	1	0	4
Collision of train with tank truck	2	0	0	2
Collision of train with truck	1	0	0	1
Chemicals and explosives, miscellaneous:				
Fireworks in hands of children	0	0	3	3
Fireworks manufacturing	1	0	0	1
Motion picture film ignited in theatre	1	0	0	1
Children alone in house	0	0	9	9
Children playing with matches	0	0	8	8
Clothing ignited (see also flammable liquids on clothing):				
Bonfires, camp fires, rubbish fires	0	0	3	3
Burning gasoline	1	1	0	2
Candle	0	1	0	1
Electric stove	0	0	1	1
Falling into fires	0	0	1	1
Furnace, stove, or heater (wood or coal)	1	5	0	6
Gas heater	1	0	1	2
Matches	1	1	0	2
Molten metal at foundry	1	0	0	1
Oil stove, lamp or heater	1	0	0	1
Smoking (see also smoking in bed)	6	1	0	7
Entering or re-entering burning buildings	3	0	0	3
Escaping fires, jumped, fell, or drowned	4	1	0	5
Explosions, miscellaneous:				
Butane	5	1	1	7
Coal tar dust	5	0	0	5
City gas	2	1	0	3
Grain dust	8	0	0	8
Industrial explosion, unknown	1	0	0	1
Fire fighting—firemen	13	0	0	13
Fire fighting—private	3	0	0	3
Flammable liquids and vapors:				
Acid tank explosion at glass works	1	0	0	1
Alcohol fires and explosions	1	0	0	1
Ammonia fires and explosions	2	0	0	2
Cement mixer explosion	1	0	0	1
Flammable liquids on clothing	1	0	2	3
Flammable liquid fires on tank ships	3	0	0	3
Flammable termite fumigant explosion	1	0	1	2
Gasoline lanterns and stoves	1	1	0	2
Gasoline pump at filling station	0	1	1	2
Home dry cleaning	0	5	0	5
Other cleaning with gasoline	1	0	0	1
Naphtha explosions and fires	6	0	0	6
Oil refinery fire	1	0	0	1
Oil stoves and burners	1	0	0	1
Oil storage tank	2	0	0	2
Oil well fires	3	0	0	3
Paint and varnish removers	1	0	0	1
Starting fires with gasoline	0	1	0	1
Starting fires with kerosene	5	5	5	15
Gasoline fires, not otherwise classified	8	3	4	15
Flammable liquid fires, not otherwise classified	1	0	0	1
Forest or brush fires, including fire fighting	6	0	0	6
Indirect causes:				
Over-exertion at fires	0	1	0	1

Class of Fire	Men	Women	Children	Total
Over-exertion at fires, firemen	3	0	0	3
Response to alarms	6	0	0	6
False alarms	2	0	0	2
Mine fires and explosions	86	0	0	86
Overcome by smoke in burning buildings	5	4	1	10
Smoking in bed	4	0	1	5
Trapped in burning buildings	64	37	47	148
Trapped in incendiary fires	5	1	2	8
No data—burned	1	0	0	1
Totals	348	92	99	539

entirely in flames when the brigade arrived, and some of the boys were jumping from windows with their clothes in flames. Fourteen of them died.

JULY 24, 1938, BOGOTA, COLOMBIA. Forty-two spectators were killed when an airplane at an air show crashed and burst into flames in the middle of the crowd. Burning gasoline was thrown about in all directions, burning to death many who were not hit by the plane.

SEPTEMBER 4, 1938, LONDON, ENGLAND. A Royal Air Force plane crashed on the roof of a house in a London suburb, fell to the street and then bounced to the roof of another house and burst into flames. While residents tried to get it off the second roof there was an explosion which threw gasoline over the crowd of spectators. When the fire brigade arrived three houses were on fire and four people had been burned to death in them; five others who were in the street had been killed by the crash and explosion of the plane, and the pilot, who was flying alone, was dead in the wrecked ship.

SEPTEMBER 6, 1938, TAKAOKA, JAPAN. A typhoon started a conflagration which destroyed more than 2000 buildings and caused an estimated 100 deaths.

Typical Loss of Life Fires.

Automobile Trailer Fires.

APRIL 2, 1938, DESERT CENTER, CALIF. A very young child was trapped and burned to death in the trailer which was his home. (H-42496.)

MAY 24, 1938, ENGLEWOOD, COLO. Along the Platte River outside the city of Englewood is an area where "squatters" put up tents or park trailers for a time under no supervision. One of these trailers, belonging to an unemployed carpenter, had been there for several months, propped up on blocks with wheels removed, and was used, together with a tent pitched alongside, as the home for the carpenter, his wife, and their four children. The trailer was also used as a chicken coop, and directly beside the only door a home-made brooder, operated by kerosene lanterns, was set up. One night while the parents were at a motion picture show and the children were asleep in the trailer, wind blew over the kerosene lanterns and started a fire. The two older children escaped, but the younger ones were burned to death. (H-42497.)

International.

In New York City, an hour after midnight on May 3, a fire department pumper was speeding to an apartment fire at the same time that a fire department rescue truck was answering a call to remedy a leaking refrigerator. Two firemen were killed and many injured when they met at an intersection. Gasoline tanks were ruptured, causing a serious fire which damaged near-by buildings. (L-4423.)

Boats and Ships.

APRIL 1, 1938, GLOUCESTER, MASS. Three men aboard a fishing schooner that was being prepared for a trip were burned when there was a flash of fire from the engine as they tried to get it started while using a blow torch. The boat was ignited. One of the men died later from his burns and partial asphyxiation. (H-42501.)

APRIL 19, 1938, off ORCAS ISLAND, FLA. A fishing boat with four men and a woman aboard exploded from unknown cause and all were killed. (H-42500.)

JULY 1, 1938, off PRINCE RUPERT, B. C. A man and his son were burned to death when there was a gasoline explosion aboard their boat and the boat was ignited. Three other sons and a daughter were able to escape into the dinghy, but in the excitement the small rowboat was overturned and they were forced to cling to its upturned bottom until help arrived. (H-42502.)

JULY 31, 1938, WOONSOCKET, R. I. An explosion aboard a small boat was touched off by a backfire and injured seven persons, one fatally. (H-42504.)

Children Playing with Matches.

JUNE 2, 1938, PARSONS, KANSAS. A child was rehearsing for her birthday party by carrying a tin can, symbolizing a cake, on which was a lighted candle. A burst of wind blew the flame against her dress and ignited it. She was burned to death. (L-4404.)

JUNE 8, 1938, COUNCIL BLUFFS, IOWA. A child, trying to light a candle while alone with a sister in the house of her parents, set fire to her dress. Her sister, 13 years old, remembered to wrap her in a blanket, and then rushed for aid. When she returned, however, the fire had broken out again, and the little child was dead. (L-4405.)

JUNE 28, 1938, BEAVER CROSSING, NEB. A child poured some gasoline into her doll stove and lit it with a match. The stove exploded, burning the child to death. (L-4406.)

Acme.

The rear of a four-story brick tenement in uptown New York after a man and woman had been suffocated in a fire at four o'clock on the morning of June 11. While all who awakened were able to escape, fire-trap conditions are indicated by the fire escapes; one with ladders from balcony to balcony which, besides being unduly difficult to descend, are too short; and the other has no usable means of descent at all. (H-42485.)

JULY 7, 1938, MONTREAL, P. Q. Several children were alone in a house playing with matches. One of them set fire to the clothes of a fifteen-month-old boy. The boy was burned to death. (L-4407.)

Escaping Fires.

MAY 12, 1938, SALISBURY, MD. A garage operator had driven to his garage on his motorcycle, and, just as he arrived, his clothing was ignited, presumably from the hot exhaust. He rushed to the rear window of the garage and plunged into a river there, where he was drowned. (H-42505.)

JULY 25, 1938, OLNEY, ILL. A man was at the top of an oil derrick when the oil well began to burn. Faced with the probability of being burned alive, he plunged sixty feet to the ground. He died of a fractured skull. (H-42506.)

Forest Fire.

APRIL 27 ,1938, SANDWICH, MASS. A Cape Cod brush fire was responsible this year for the death of three fire fighters. The firemen were caught between the main blaze and a backfire when the wind shifted. (H-42507.)

International.

The Tuxedo Park, N. Y., home of a young married couple after an early morning fire on August 9 had burned them to death. Their baby boy and his nurse escaped by jumping through a window. (L-4422.)

Fireworks Deaths.

MAY 25, 1938, WEST HANOVER, MASS. A workman, making fireworks for the Fourth of July celebration, was burned to death at the fireworks factory where he was employed. Some fireworks exploded. (H-42508.)

JULY 4, 1938, SHAD POINT, MD. Three boys were preparing a homemade bomb in a basement by pouring gunpowder from firecrackers into a piece of pipe. The bomb exploded prematurely, killing the youngest of the group, 11, blowing a leg and the fingers of a hand off another, 15, and removing the toes of one foot from the other, 25. (L-4411.)

JULY 4, 1938, SOUTHAMPTON, L. I. Three young girls were lighting fireworks. One of them accidentally dropped a match into the clothing of another. Her dress ignited, burning her fatally. (L-4412.)

JULY 5, 1938, POOLESVILLE, MD. Playing with sparklers on the day after the Fourth of July celebration, a girl touched the red hot wires to her dress and burned herself to death. (L-4413.)

Termite Fumigation.

JULY 1, 1937, TERRE HAUTE, IND. A crew of men were treating a house for termites with a solution of creosote in gasoline. The solution was applied to the timbers by means of a compressor and hose with nozzle. The men had

completed work in the basement and were treating the underfloor of a sun porch through a small opening on the outside, illuminating the area with an extension cord light and reflector. At the conclusion of the work the man handling the nozzle started to pull out the hose and the light at the same time. The bulb was broken in the process and a sheet of flame shot from the hole, burning both himself and a young child who was looking on so severely that they soon died.

Investigation showed that the solution being used had a flash point below ordinary room temperature, and that this fact was not noted on any of the equipment. The fire department experienced great difficulty extinguishing the fire in the house which followed, for the timbers were saturated with the flammable liquid. (H-42509.)

Smoking in Bed.

APRIL 25, 1938, JERSEY CITY, N. J. A man was burned to death when he fell asleep while smoking in bed. (L-4414.)

JULY 13, 1938, BOSTON, MASS. Two men living in a basement apartment had returned home to take a nap in the afternoon. One of them lay down on the couch and smoked a cigarette. He fell asleep while smoking, and the cigarette dropped on the couch, where it started a smouldering fire in the upholstery. He was suffocated without being awakened. His roommate was rescued and subsequently arrested for drunkenness. (L-4416.)

Flammable Liquids on Clothing.

JUNE 26, 1938, BEMIDJI, MINN. A man was draining gasoline from a gasoline stove at a CCC camp. In an unexplained manner the gasoline was ignited, starting a fierce fire in his clothes which had been saturated with the liquid. He died of his burns. (L-4417.)

Gasoline Stove Explosions.

JUNE 13, 1938, INDIANAPOLIS, IND. A gasoline cooking stove exploded in a home, fatally burning the woman who was operating it. (L-4418.)

JULY 4, 1938, INDIANAPOLIS, IND. A man was repairing a gasoline camp stove when it exploded. His clothing was ignited, and he was fatally burned. (L-4419.)

Response to Alarms.

JUNE 2, 1938, SEATTLE, WASH. A fire chief's automobile crashed into a car driven by a baker at a crossing as he rushed to a fire with the siren going. The battalion chief driving the fire department automobile was killed, and the baker and another chief were seriously injured. (L-4420.)

JULY 17, 1938, DENVER, COLO. A pumper crashed into a 14-ton ladder truck on the way to a fire in an amusement park. Two firemen were killed. Several other persons were injured, both on the fire apparatus and in two automobiles which were also involved in the crash. (L-4421.)